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Dibromochloropropane (DBCP)
Final Position Document

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Jeff Kemper, and Mitchell H. Bernstein.

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The report is a preliminary risk assessment for dibromochloropropane (DBCP). It gives a preliminary examination of its use, environmental residues, and health effects including toxicology data. Limited information is provided for exposure and extent of risk. Results of a literature search are provided.

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DIBROMOCHLOROPROPANE (DBCP): FINAL POSITION DOCUMENT

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OFFICE OF PESTICIDE PROGRAMS
U.S. ENVIRONENTAL PROTECTION AGENCY

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DIBROMOCHLOROPROPANE

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DIBROMOCHLOROPROPANE (DBCP): FINAL POSITION DOCUMENT

I. Introduction

A. The Statute

The Federal Insecticide, Fungicide, and Rodenticide Act, as amended ("FIFRA") (7 U.S.C. §136 et seq.) regulates all pesticide products. Under §12(a)(1)(A) of FIFRA all pesticide products must be registered before they may be sold or distributed. Before the Administrator may register a pesticide, however, he must determine that its use will not result in "unreasonable adverse effects on the environment," defined by §2(bb) of FIFRA to mean "any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide." In other words, any decision concerning registration must take into account both the risks and the benefits from the use of the pesticide.

Section 6(b) of FIFRA authorizes the Administrator to issue a notice of intent to cancel the registration of a pesticide or to change its classification if it appears to him that the pesticide or its labeling "does not comply with the provisions of [FIFRA] or, when used in accordance with widespread and commonly recognized practice, generally causes unreasonable adverse effects on the environment." Thus, the Administrator may cancel the registration of a pesticide whenever he determines that it no longer satisfies the statutory standard for registration; that standard requires, among other things, that the pesticide not cause "unreasonable adverse effects on the environment" (FIFRA §3(c) (5)(C)). He may also cancel the registration of a pesticide if its labeling does not comply with the misbranding provisions of FIFRA which require the labeling to contain language "adequate to protect health and the environment" (FIFRA §2(q)).

B. The "RPAR" Process

The Agency has designed a process to gather risk and benefit information about a problem pesticide and to make a balanced decision concerning it in an open manner allowing maximum participation by all interested groups. This process is known as the Rebuttable Presumption Against Registration process; it is set out in 40 CFR §162.11.

In broad summary, these regulations describe various risk criteria, and provide that a Rebuttable Presumption Against Registration ("RPAR") shall arise if the Agency determines that any of those criteria has been met. Once a rebuttable presumption has arisen, registrants, applicants and interested persons are offered an opportunity to submit evidence in rebuttal of the presumption. Those persons may also submit evidence on the economic, social and environmental benefits of any use of the pesticide. If the presumptions of risk are not rebutted, the benefits evidence submitted to or gathered by the Agency is evaluated and considered with the risk information. Various risk reduction methods and their costs are then analyzed and it is determined whether the pesticide may be regulated by their use so as to strike the statutory balance between risks and benefits. If the statutory balance cannot be achieved for any use, the registrations of the pesticide for that use must be cancelled.

C. Regulatory Actions Concerning DBCP

(1) Issuance of the RPAR

On September 15, 1977, the Agency's Office of Pesticide Programs ("OPP") issued a Notice of Rebuttable Presumption Against Registration and Continued Registration of Pesticide Products Containing Dibromochloropropane (DBCP) (42 FR 48026, September 22, 1977). That notice was supported by Position Document 1 on DBCP, which described the physical and chemical characteristics of DBCP, its registered uses and existing tolerances, and the toxicological test results then available about it. Position Document 1 also described the evidence supporting the conclusions that DBCP met two RPAR risk triggers: the oncogenic trigger (§162.11(a)(3)(ii)(A)); and the "other chronic or delayed toxic effects" trigger (§162.11(a)(3)(ii)(B)), based on evidence of its adverse reproductive effects in males.

(2) Suspension of DBCP

Based on the results of an intensive, expedited investigation of the human health hazards of DBCP, the Administrator determined on September 8, 1977 that suspension of the registrations of DBCP products was "necessary to prevent an imminent hazard during the time required for cancellation or or change in classification proceedings" (FIFRA §6(c)). Accordingly, the Administrator issued on that date a Notice of Intent to Suspend and Conditionally Suspend Registrations of Pesticide Products Containing Dibromochloropropane (42 FR 48915, September 26, 1977) ("Notice of Intent to Suspend"). */

On October 27, 1977, the Administrator issued a Suspension Order which suspended the registrations of all pesticide products containing DBCP (42 FR 57543, November 3, 1977). The Suspension Order implemented two separate suspension actions: an unconditional "specific food use" suspension of DBCP products registered for use on any of nineteen (19) food crops, and a conditional suspension of all DBCP products. Under the conditional suspension, registrants were afforded an opportunity for relief from the Suspension Order by obtaining an interim registration amendment implementing certain classification and labeling changes as set forth in the Suspension Order.

Section 6(c)(1) of FIFRA states that no suspension order may be issued unless a notice of intent to cancel the registrations or change the classifications of the pesticide products

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*/ "Imminent hazard" is defined by FIFRA as "a situation which exists when the continued use of a pesticide during the time required for cancellation proceeding would be likely to result in unreasonable adverse effects on the environment . . . " (FIFRA §2(1)).

concerned has already been issued, or is issued with the suspension order. Accordingly, on October 27, 1977, the Administrator also issued a Notice of Intent to Cancel the Registrations or Change the Classifications of Pesticide Products Containing Dibromochloropropane (DBCP), and Statement of Reasons (42 FR 57545, November 3, 1977) ("Notice of Intent to Cancel").

As explained in the Notice of Intent to Cancel, the information then available to the Agency on the issues relevant to an ultimate cancellation decision, including information on both the risks and benefits of DBCP, was incomplete. The Administrator further noted that the RPAR process--which was already initiated for DBCP--was designed precisely to permit the Agency to gather the best available information about a problem pesticide. Accordingly, the Administrator determined that the decisions reached in the RPAR review, embodied in this Final Position Document, could form the basis of an amendment to the Notice of Intent to Cancel.

(3) OSHA Standard for Occupational Exposure to DBCP

On March 17, 1978, the Occupational Safety and Health Administration ("OSHA") published an occupational safety and health standard for occupational exposures to DBCP. Among other things, the standard limits employee exposure to DBCP in the workplace to 1 part DBCP per billion parts of air (1ppb) as an 8-hour time-weighted average and prohibits all eye and skin contact with DBCP (43 FR 11514).

The permanent standard was promulgated through notice-and-comment rulemaking after an informal public hearing; it superseded the emergency temporary standard ("ETS") issued by OSHA on September 9, 1977 (42 FR 45536).

OSHA's issuance of the ETS was coordinated with the Agency's issuance of the Notice of Intent to Suspend, and both agencies have cooperated in the formulation of an overall regulatory strategy designed to protect the public against the hazards of DBCP. The permanent OSHA standard specifically states that it does not apply to "exposure to DBCP which results soley from the application and use of DBCP as a pesticide" (29 CFR 1910. 1044; 43 FR 11527, March 17, 1978). Those exposures are precisely the ones which the Agency reviewed in the RPAR process. The Agency believes that the actions which it is proposing today complement the permanent OSHA standard and provide comprehensive protection to all members of the public against the risks from all DBCP exposures.

D. Organization of This Final Position Document

This Final Position Document contains six parts. Part I is this introductory section. Part II is an evaluation of the risks associated with DBCP on which the RPAR action was based. It includes descriptions of experimental and epidemiological data, Agency responses to RPAR rebuttal comments, and the final Agency

Agency responses to RPAR rebuttal comments, and the final Agency assessment of those risks. Part III is a description of the process which the Agency used to gather and analyze information on the economic benefits of DBCP, on a use-by-use basis. Part IV describes the range of regulatory options available to the Agency for the reduction of unreasonable risks, and explains the basis of the Agency's selection of six alternative courses of action for each registered use of DBCP. Part V is the Agency's evaluation of the risks and benefits associated with DBCP on a use-by-use basis, including an evaluation of the risks from substitute chemicals for DBCP, and the Agency's evaluation of the viability of each available regulatory option. The beneficial and adverse impacts of each option are evaluated, and the rationale for the final decision on each use is set forth. Finally, Part VI summarizes the regulatory action which the Agency proposes to take, in the aggregate, concerning the registrations of pesticide products containing DBCP.

II. Risk Assessment of DBCP

In its Notice Of Intent To Suspend, the Agency assessed the potential human health risks to persons exposed to DBCP. This assessment was performed in three parts. First, the toxicological effects of DBCP, as demonstrated in laboratory animal tests or in human epidemiological studies, were identified. Second, the populations likely to be exposed to DBCP, and the routes of their exposures, were identified, and the durations and levels of their exposures were estimated. Third, based on these estimates and using appropriate mathematical models, the degree of risk to each exposed population was either quantified or qualitatively described.

This Final Position Document uses the same approach. The scope of review, however, has been expanded to include new data submitted in rebuttal comments to the RPAR, and new data obtained or generated by the Agency during the RPAR review.

A. Toxicological Effects Of DBCP In Laboratory Animals And In Humans

(1) Cancer

(a) Laboratory Animal Studies

i. Between 1972 and 1974, the National Cancer Institute (NCI) sponsored a long-term bioassay of DBCP for possible carcinogenicity, using Osborne-Mendel rats and B6C3F1 mice, at Hazleton Laboratories. DBCP in corn oil was administered by gavage (i.e., by a tube into the stomach) 5 days a week to groups of 50 males and females of each species, at two dose levels per species. The time-weighted average doses of DBCP in this chronic study were 29 mg/kg/day for the high dose rats of both sexes, and 15 mg/kg/ day for the low dose rats of both sexes; the time-weighted average doses for the high dose male and female mice were 219 and 209 mg/kg/day, respectively, and for the low dose male and female mice were 114 and 110 mg/kg/day, respectively.

For each species, 20 animals of each sex were used as vehicle controls, and were intubated with corn oil at the same time that dosed animals were intubated with DBCP mixtures. In addition, 20 animals of each sex were placed on test as untreated controls for each species, and did not received any gavage treatments.

DBCP was administered to the high dose male and female rats for 64 weeks prior to sacrifice, and to the low dose female rats for 73 weeks prior to sacrifice. The low dose male rats were treated for 78 weeks, followed by an additional 5 weeks of observation. The high dose male and female mice were treated for 47 weeks prior to sacrifice; the low dose male mice were treated for 59 or 60 weeks prior to sacrifice; and the low dose female mice were treated for 60 weeks prior to sacrifice.

The results of that study have been published by the NCI in "Bioassay of Dibromochloropropane for Possible Carcinogenicity" (NCI, 1978).

The report concluded (at p.v):

> "In rats and mice of both sexes, statistically significant incidences of squamous-cell carcinomas of the forestomach occurred in each dosed group and a significant positive association existed between dosage level and tumor incidence. The incidences of adenocarcinomas of the mammary gland were statistically significant in female rats when the treated groups were compared to the controls. Toxic nephropathy was also observed at elevated incidences in all of the treated rats and mice when compared to their respective untreated or vehicle control groups.
>
> "Under the conditions of this study, DBCP is a stomach carcinogen in rats and mice of both sexes and is carcinogenic to the mammary gland in female rats."

ii. A bioassay on albino rats, sponsored by Dow Chemical Company, was also conducted at Hazleton Laboratories. DBCP was administered in the diet at levels of 0.3, 1.0, and 3.0 mg/kg/day for 104 weeks, to groups of 60 female and 60 male rats for each dose. An additional group of 60 female and 60 male rats served as the control group and received the laboratory diet only.

A 78-week progress week report received by the Agency on July 21, 1977 indicated a statistically significant incidence of "possible neoplasms" of the stomach, in both males and females receiving 1.0 and 3.0 mg/kg/day (Piccirillo, 1977).

On November 8, 1977, Dow submitted its "Final Report, 104-week Dietary Study in Rats, Project No. 174-122", dated October 28, 1977, to the Agency as part of Dow's rebuttal comments to the RPAR (RPAR Comment No. 3A, [30000/19]). That report, as well as the transmittal letter, indicated "a higher than control incidence of raised areas or nodules in the stomachs of the mid- and high-dose males and females," but did not include the results of any histopathologic examinations. In July of 1978, Dow submitted Hazleton's "Supplementary Histopathology Report to Final Report dated October 20, 1977" (Hazleton Laboratories, 1978). Although its late submission precluded detailed Agency review, the report did conclude that dietary administration of DBCP "resulted in a tumorigenic effect in the kidneys and nonglandular region of the stomach ...."

iii. Dow Chemical Company has sponsored another bioassay at Hazelton Laboratories, using groups of 50 male and 50 female Hazleton Laboratories, albino mice which were administered DBCP in the diet at levels of 0, 0.3, 1.0 and 3.0 mg/kg/day for 78 weeks. The Agency received a copy of a "52-Week Progress Report" in August, 1977 (Schober, 1977). Although the study was scheduled to be terminated in December of 1977, the Agency has not yet received any final report or histopathological evaluations from the study.

iv. Another bioassay is currently in progress at the NCI, in which mice and rats are being exposed to 0.6 and 3.0 ppm DBCP via inhalation. The results of that study will not be available for several months.

v. The Agency has received a preliminary report from Professor Van Duuren of New York University Medical Center on a skin bioassay of DBCP in groups of 30 female Swiss mice. Although the histopathology was still incomplete at the time of the report, the report indicated a high incidence of tumors, including squamous carcinomas of the forestomach, in the treated animals (Van Duuren, 1978).

(b) CAG Determination Of Carcinogenicity

The Agency's Carcinogen Assessment Group ("CAG"), an advisory body which analyzes of data related to the carcinogenicity of test substances, makes judgments concerning the human risk of suspected carcinogens. These analyses are performed in accordance with the Agency's "Interim Procedures and Guidelines for Health Risks and Economic Impact Assessment of Suspected Carcinogens" (41 FR 21402, May 25, 1976) (The "Cancer Guidelines"). */

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*/ The Cancer Guidelines represent the Agency's accumulated expertise concerning the identification and assessment of carcinogens. The approach taken in the Cancer Guidelines is

(CONTINUED)

Although the final NCI report was not formally released by NCI until 1978, at the time of issuance of the RPAR the CAG had available to it, and reviewed, the final tabular data from that study. The CAG determined that DBCP produces high levels of squamous cell carcinomas of the stomach in rats and mice of both sexes at both exposure levels. Among rats, gastric carcimonas were observed in 47/50 (94%) of the high dose males, 47/50 (94%) of the low dose males, 29/49 (59%) of the high dose females, and 38/50 (76%) of the low dose females. Among mice, the gastric carcinomas were observed in 47/49 (96%) of high dose males, 43/46 (93%) of the low dose males, 47/48 (98%) of the high dose females, and 50/50 (100%) of the low dose females. These incidences were highly significant (p less than .001) when compared to both the vehicle and untreated controls for both species, in which zero gastric carcinomas occurred.

In addition, both DBCP-treated groups of female rats showed significant increases (p less than .005) in the incidence of mammary adenocarcinomas. Mammary adenocarcinomas occurred in 31/50 (62%) of the high dose female rats, 24/50 (48%) of the low dose female rats, and in 2/40 (5%) of both controls combined.

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*/ Continued from previous page
generally supported by the final report of the National Cancer Institute's National Cancer Advisory Board Subcommittee on Environmental Carcinogenesis, entitled "General Criteria for Assessing the Evidence for Carcinogenicity of Chemical Substances" (also known as the "Shubik Committee Report").

The CAG also observed that the times to tumor tended to be very short, and that the tumors metastasized to a wide variety of other organs. Accordingly, the CAG concluded that:

> "There is strong evidence that DBCP is likely to be carcinogenic to man." (CAG, 1977)

(c) RPAR Rebuttal Comments

The only comment submitted in rebuttal of the Agency's determination of the carcinogenicity of DBCP was the statement of Dr. Gehring, Director of the Toxicology Research Laboratory of Dow Chemical USA (RPAR Comment No. 3A [30000/19]). Dr. Gehring questioned whether the excess cancer observed in the NCI-study was in fact due to a primary carcinogenic effect of DBCP, and argued that the doses used produced severe debilitation and excessive mortality which may have contributed to the effects observed.

In response, the CAG noted that there is no evidence that nonspecific organ damage is the cause of cancer. Indeed, it stated that excessive toxicity and mortality would be expected to suppress carcinogenicity. (Albert, 1978). Moreover, Dr. Gehring did admit that the NCI study indicated that cancer "may be induced by ingestion of DBCP"; he further stated that that conclusion "has been rendered more valid" by the interim results of the Dow-Hazleton rat study, since the doses used in that study "are unlikely to have caused irritation sufficient to increase the induction of cancer and these doses do not appear to have affected dramatically the health status of the rats on test" (RPAR Comment No.3A [30000/19]).

Similarly, Dr. Gehring suggested that the method of administration (i.e., by gavage) may have contributed to the induction of the observed neoplasms, since DBCP is a skin and mucous membrane irritant and proliferative lesions of the forestomach have been noted in other bioassays where chemical irritants have been administered by gavage.

In response, the CAG noted that most of the halogenated aliphatic hydrocarbons, including DBCP, are known to be skin and mucous membrane irritants. However, it also noted that the NCI had tested thirteen aliphatic hydrocarbons for carcinogenicity; they were administered by oral intubation in 200 Osborne-Mendel rats and 200 B6C3F1 mice of both sexes. Of the thirteen compounds tested, only three induced squamous-cell carcinomas of the forestomach. (Albert, 1978). In addition, Dr. Gehring admitted that the results of the Dow-Hazleton study validate the conclusion that ingestion of DBCP causes cancer, since the doses used in that experiment were unlikely to have caused irritation sufficient to increase the induction of cancer (RPAR Comment No. 3A [30000/19]).

(d) Conclusions on the Carcinogenicity of DBCP

The Agency concludes that the presumption of risk arising from the "oncogenic trigger" (§162.11(a)(3)(ii)(A)) has not been rebutted for DBCP since no applicant or registrant has sustained the affirmative burden of proof set forth in §162.11(a)(4).

Since valid data demonstrate that DBCP is a strong carcinogen in both sexes of two animal species, the Agency concludes that DBCP presents a significant risk of cancer to human beings who are exposed to the chemical.

(2) Adverse Reproductive Effects

(a) Laboratory Animal Studies

In the Notice of Intent to Suspend, the Agency summarized several published reports which indicated that DBCP significantly damages the testes of several animal species. In particular, the studies published by Torkelson (1961) showed that groups of 15 rats exposed to DBCP vapors of 0, 5, 10, 20, or 40 ppm for a total of 50 exposures over 7 weeks, developed gross lesions in the testes at the 10 ppm and higher dosages. Testes atrophied in treated rats at 20 and 40 ppm, while testicular weight was reduced in some males at as low as 5 ppm. In addition, three male rabbits and 10 male guinea pigs exposed to 12 ppm DBCP vapors 66 times showed severe testicular atrophy and degeneration. The authors noted that "the most striking observation at autopsy was severe atrophy and degeneration of the testes of all species."

The Notice of Intent to Suspend also referred to several Russian studies which indicated adverse reproductive effects in rats resulting from exposures to DBCP. (Faidysh et al. 1974, Faidysh et al. 1970, Rakhmatullayev 1971, Reznik and Sprinchan 1975).

However, Agency scientists have identified several factors which preclude comparison of the Russian results with those of Torkelson. For example, the chemical analysis of Russian DBCP is not provided; the "index of spermatogenesis" is not defined; and many of the studies were performed with only one dose with no description of how that dose was chosen. Accordingly, the Agency can now only conclude that the results and conclusions of the Russian studies are apparently similar to those described above.

Three other sets of experimental data, not cited in the Notice of Intent to Suspend, have also been found in the course of the RPAR review. First, the NCI's "Bioassay of Dibromochloropropane for Possible Carcinogenicity" (NCI, 1978) referred to in Section II A (1)(a) earlier, includes a table "Summary of the Incidence of Nonneoplastic Lesions in Male Rats Treated with DBCP." The table indicates that atrophied testicles were observed in 76% (38/50) of male rats receiving 15 mg/kg/day, 5 days/week, for 78 weeks, and in 96%(47/49) of male rats receiving 29 mg/kg/day, 5 days/week, for 64 weeks.

Second, the Dow Chemical Company reports that in the Hazleton Laboratories chronic ingestion study cited earlier in Section II A (1)(a), no DBCP-related histomorphologic alterations were revealed by examination of the testes of the high dose (3 mg/kg/day) treated rats (RPAR Comment No. 3A [30000/19]).

The Agency has not reviewed the raw data underlying these histopathological conclusions.

Third, Shell Oil Company submitted the results of a study by the Department of Pharmacology and Experimental Therapeutics, University of California, School of Medicine, which were not reported by Torkelson (Hines et al., 1956) (RPAR Comment No.20A [30000/19]). In that study, groups of 15 rats were repeatedly exposed to 5, 10, 20 and 50 ppm DBCP for 7 hours/day, 5 days/week, for 77 days. According to Shell, the histopathological examination of all organs, including testes, revealed pathologic changes only in the lungs. However, Shell admitted in its rebuttal comment that these are "remarkedly different results" from a second inhalation study performed at the same facility, which was reported by Torkelson.

(b) Human Epidemiologic Studies

Medical evidence of adverse effects in humans resulting from exposure to a pesticide is significantly more valuable than laboratory animal tests for judging the chemical's potential for human harm. Accordingly, preliminary indications of depressed sperm counts in workers at plants where DBCP was manufactured or formulated, reported in the Notice of Intent to Suspend, gave rise to intense investigations into adverse reproductive effects in males resulting from exposure to DBCP by several other chemical companies, by the National Institute of Occupational

Safety and Health ("NIOSH"), and by the Agency.

As the result of those investigations, the Agency has received extensive epidemiologic information about males exposed to DBCP. The data fall into three groups: data from manufacturers/ formulators of DBCP products; an in-depth study of the Occidental Chemical Company workers exposed to DBCP, performed by Dr. Whorton; and the results of a survey of agricultural workers potentially exposed to DBCP, conducted by the Human Effects Monitoring Branch of OPP's Technical Services Division.

The primary focus in the Agency's review and evaluation of these data was evidence of testicular toxicity, as might be manifested by such clinical signs as decreased or depressed sperm counts, low motility of sperm, abnormal sperm morphology, and variations in sex hormone levels. Because sperm counts -- measured in terms of millions of sperm per milliliter of semen (MM/ml)--provide objective data amenable to statistical analysis, they were used by the Agency as the principal index of testicular toxicity.

However, the Agency wishes to emphasize that statistical analyses of sperm count levels are not attempts to predict or gauge the fertility or infertility of any male tested. Theoretically, as long as a male has a sperm count above zero, he is capable of reproducing; the chances of successful conception increase with increased sperm count, all other reproductive variables being constant and within normal limits. Accordingly, an analysis of sperm count data indicating a depressed sperm count in any exposed population does not mean that the affected individuals (with the exception of azoospermics, persons with zero sperm counts) are or will be incapable of fathering children.

The threshold issue with respect to using sperm counts as the index of testicular toxicity is the choice of a "normal" sperm count for comparison. It is well established that the sperm counts range from 0 sperm to over 300 million sperm per milliliter; the distribution of these sperm counts may be described in increments of 10 MM/ml— i.e., the percentage of men with counts less than 10 MM/ml, the percentage from 10 MM/ml to 20 MM/ml, etc. At the informal public hearing on the proposed OSHA standard for occupational exposure to DBCP, expert witnesses testified to two factors:

(1) there is little disagreement among experts that a sperm count of 40 MM/ml or more can be considered a normal value (Whorton, 1977); and

(2) any sperm count below 20 MM/ml would be considered abnormally low, or oligospermic (Marshall, 1977). An area of limited controversy exists about how to best characterize sperm counts in the range of 20-40 MM/ml, which Dr. Whorton described as "mildly oligospermic".

The Agency has determined that 40 million sperm per milliliter is the appropriate upper limit of the range of oligospermic sperm counts. The primary reason for this decision is the Agency's concern for human health hazards from DBCP; as a matter of policy, the Agency believes it prudent to adopt a conservative approach in the assessment of human risks, current scientific consensus. However, to present a more complete picture of the available data, the Agency has performed all of its statistical analyses with both 20 MM/ml and 40 MM/ml as the upper limit of the range of oligospermia.

The second issue concerning the use of sperm counts is the choice of a "standard" distribution of sperm counts for statistical comparison. For this purpose the Agency has used the one compiled by McLeod (1977), which was presented at the NIOSH conference on DBCP held in Cincinnati on October 20 and 21, 1977. McLeod sampled 9,000 men examined over 11 years from 1966 to 1977, in conjunction with "infertile marriage" consultations. Dr. Channing Meyer, chief of the medical section in the branch of NIOSH charged with investigating toxic hazards in the workplace, discussed McLeod's data at the informal public hearing on the proposed OSHA standard for occupational exposures to DBCP; he explained that in any sample of individuals seeking counseling because of infertility problems, the responsibility for the infertility will rest with the male about half of the time and with the female about half of the time. (Dr. Meyer, 1977). Accordingly, about half of the men in McLeod's test population could be expected to have fertility problems, including low sperm counts, therefore, the frequency distribution of "normal" sperm counts derived from that test population would be biased downward relative to the general population of non-vasectomized males.

This inference is supported by a comparison of McLeod's "infertile marriage" data with other data collected by McLeod (1951) in an earlier study of fertile males. Sperm counts less than 20 MM/ml comprise 15% of the "infertile" group (excluding azoospermics) compared to only 5% of the fertile group; for sperm counts less than 40 MM/ml, the figures are 26.4% and 17%, respectively.

To the extent that the frequency of sperm counts below 20 MM/ml or 40 MM/ml in any epidemiological study exceed at a statistically significant level the frequency below 20 MM/ml or 40 MM/ml, respectively, in McLeod's "infertility" data, the Agency will be even more confident in concluding that the results demonstrate adverse human reproductive effects from DBCP exposure. Finally, it should also be noted that for purposes of analysis, non-vasectomized azoospermics were included in both the "less than 20 MM/ml," and "less than 40 MM/ml" categories. McLeod's "infertile marriage" data were adjusted accordingly to reflect the inclusion of azoospermics, so that the frequency of sperm counts less than 20 MM/ml was 18.1% and of sperm counts less than 40 MM/ml was 29.1%.

(1) The data received from manufacturers and formulators are summarized in Table 1, together with the results of statistical analyses performed by the Agency.

At the Occidental plant, 40 of 91 workers who were exposed to DBCP (44%) had sperm counts below 40 MM/ml, compared to only 4 of 35 workers who were not exposed to DBCP (11%). This difference was highly statistically significant (p less than 0.005). No data on sperm counts less than 20 MM/ml were available.

At two other plants -- the Dow (Magnolia) plant and the Velsicol plant — no control data were available on workers not exposed to DBCP, so that the McLeod "infertile marriage" data were used for statistical analysis. At the Dow plant, 53 of 117 workers exposed to DBCP (45%) had counts below 20 MM/ml, compared to 18.1% of McLeod's sample; 68 of 117 (58.1%) had counts below 40 MM/ml, compared to 29.1% of McLeod's sample. Both comparisons indicated that the differences in frequencies were highly statistically significant (p less than 0.005). At the Velsicol plant, 12 of 24 workers exposed to DBCP (50%) had counts below 20 MM/ml and 17 of 24 (70.8%) had counts below

40 MM/ml. Again, these frequencies were highly significantly different from the McLeod data (p less than 0.005).

The Agency believes that these data clearly indicate that exposure to DBCP of workers in certain manufacturing or formulating plants has resulted in depressed sperm counts in those workers.

(2) A second epidemiologic study reviewed by the Agency is the "Health Hazard Evaluation" ("HHE") conducted from August to October, 1977 at the Occidental Chemical Company in Lathrop, California by Drs. Whorton, Milby and Stubbs (Whorton *et al*. 1977). A preliminary study at Occidental had found a clear relationship between duration of exposure to DBCP and sperm count; the HHE attempted to expand the data base to confirm that relationship. A problem in the study was accurate measurement of individual exposures to DBCP. For data analysis purposes, exposure was first coded qualitatively on the basis of work history either in the Agricultural Chemical Division ("ACD") of Occidental, or in other areas of the plant in which DBCP was formulated. Later in the study, a semiqualitative estimate of exposure was devised, relying mainly upon individual memories, to estimate length of exposure. Time in the ACD was considered *de facto* exposure time, and total time of exposure was estimated by months in the ACD or other relevant areas of Occidental. The exposures were added cumultatively to provide a sum by months;

exposure times were then divided into groups to allow meaningful statistical analysis. Exposed workers for whom no reasonable quantification could be determined were put in the category "unquantifiable exposure".

The following table, based on data from the HHE, shows the relationship between exposure to DBCP and sperm counts. */

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*/ The HHE used the value of 40 MM/ml as the upper limit of range of sperm counts considered to be oligospermic.

Sperm Count Categories	Exposure Categories (Months)						
	None	1-6	7-24	25-42	43 +	Total Exposed	McLeod
less than or equal to 40 MM/ml							
(n)	(4)	(11)	(7)	(8)	(14)	(40)	
%	11.4	22.9	50.0	66.7	82.4	44.0	29.1
greater than 40 MM/ml							
(n)	(31)	(37)	(7)	(4)	(3)	(51)	
%	88.6	77.1	50.0	33.3	17.6	56.0	70.9
totals							
(n)	(35)	(48)	(14)	(12)	(17)	(91)	(9,000)
%	100	100	100	100	100	100	100

(number of individuals in parentheses)

A clear increase in incidence of oligospermia with increased exposure to DBCP is evident from this table. The number of men in the "no exposure" group with counts greater than 40 MM/ml was eight times the number of oligospermic men in that same group. In the 1-6 month exposure category, however, the ratio was about 3 to 1; in the 7-24 month exposure category, the ratio was 1 to 1; and in the 25-42 month category, the ratio reversed so that the number of oligospermic men was twice the number of men in that category with counts greater than 40 MM/ml. An even more striking difference can be seen in the 43 month-plus exposure category, where the ratio of oligospermic men to men with counts greater than 40 MM/ml increases to almost 5 to 1.

The Agency believes the results and interpretations of the HHE support a conclusion that in workers exposed to DBCP, the incidence of oligospermia increases with increased exposure.

(3) A third study, "Spermatogenesis In Agricultural Workers Potentially Exposed to 1,2-dibromo-3-chloropropane (DBCP)," was conducted by the Epidemiologic Studies Program of OPP's Human Effects Monitoring Branch (HEMB, 1978). The purpose of the study was to evaluate individuals potentially exposed to DBCP in agricultural or related occupations to determine whether the problem of depressed sperm counts also occurred among those individuals as it had among workers who formulated the compound.

(i) The study's "South Carolina Cohort" consisted of participants from South Carolina, Florida, Arkansas, Alabama, Tennessee and Mississippi; the group of "users" included custom applicators, farmers, farm workers, researchers, and sales representatives. The study found that 16 of 45 users (35.6%) had counts below 20 MM/ml as compared to only 18.1% of the McLeod subjects (both counts include azoospermics). This difference was highly statistically significant (p less than 0.01). Moreover, the study indicates that an additional 6 users had sperm counts in the range of 20.1-40 MM/ml, so that a total of 48.9% of the users were below 40 MM/ml, as compared to only 29.1% of the McLeod subjects. This difference was highly statistically significant (p less than 0.01).

The study also developed a DBCP "use-index" for the user group, calculated by dividing the total estimated pounds of DBCP used in each user's lifetime by the total estimated number of days in which DBCP was used. The study demonstrated a significant negative correlation between sperm count and DBCP use-index— i.e., the higher the use-index value, the lower the sperm count tended to be (Spearman rank correlation coefficient -0.372; p less than 0.01). This finding supports the relationship between sperm count and exposure time shown by Whorton in the HHE.

(ii) The study's "California Cohort" consisted of agricultural workers, including commercial injection applicators and irrigation calibrators, farm hands and farm laborers, and researchers. Fifty of the workers had used DBCP for 15 to 2090 days during their lifetimes; ten had used it 1-10 days; and 23 controls had never been exposed to DBCP. Twelve farm hands and laborers, some of whom may have been incidentally exposed to DBCP, were also examined.

When all persons in the California Cohort who had used DBCP are considered, 21 of 60 (35.0%) had sperm counts less than 20 MM/ml and 31 of 60 (51.6%) had sperm counts less than 40 MM/ml, as compared to 1 of 23 controls (4.3%) and 6 of 23 controls (26.1%), respectively. These differences were statistically significant (p less than 0.005 and p less than 0.05, respectively).

(iii) The study's "Texas Cohort" consisted of fourteen citrus and vegetable farmers who had been exposed to DBCP. Six of the individuals (42.9%) had sperm counts less than 20 MM/ml, as compared to 18.1% of McLeod's subjects (p less than 0.025). Eight of the individuals (57.1%) had sperm counts less than 40 MM/ml, as compared to 29.1% of McLeod's subjects (p less than 0.025).

(iv) The Agency believes that this study amply demonstrates that exposure to DBCP in agricultural use situations poses a risk of testicular toxicity (i.e., depressed sperm counts) to exposed individuals, and that the risk increases with increased exposure.

(c) RPAR Rebuttal Comments

Both Dow Chemical Company and Shell Oil Company submitted RPAR rebuttal comments to the effect that laboratory animal data indicate a 1 ppm "no effect" level for testicular atrophy from subchronic inhalation of DBCP, the equivalent of an oral dose of 1.6 mg/kg/day. They stated that this conclusion is further supported by experimental data indicating that doses of 3 mg/kg/day of DBCP ingested for two years did not have an anti-spermatogenic effect.

The Agency does not concur with the conclusion that a "no observable effect level" (NOEL) has been established in laboratory animals; further, it does not believe that it is necessary to resolve that point since human epidemiologic evidence, discussed above, especially the HEMB survey which indicates testicular toxicity in workers exposed to DBCP in agricultural use situations. Moreover, the Agency submitted the data from the HHE to Dr. D.W. Gaylor, the Chief of Biometry of the National Center for Toxicological Research. By plotting the data on arithmetic scales, he concluded that "there is no indication of a so called no effect exposure. A very short length of exposure to DBCP may in fact result in oligospermia in a small proportion of workers" (Gaylor, 1978).

(d) Conclusions Regarding Adverse Reproductive Effects of DBCP

The Agency concludes that the presumption of risk arising from the "other chronic or delayed toxic effects "trigger (§162.11 (a)(3)(ii)(B)) has not been rebutted for DBCP since no applicant or registrant has sustained the affirmative burden of proof set forth in §162.11(a)(4).

Based on epidemiologic evidence, the Agency concludes that DBCP poses a risk of testicular toxicity, as evidenced by an increased incidence of reduced sperm counts, to males who are exposed to the chemical. The Agency further concludes from that data that no "no observable effect level" may safely be established for human exposure to DBCP with respect to testicular toxicity, and further concludes that the risk of decreased sperm counts increases with increased exposure.

(3) Other Toxicological Effects

Other toxicological effects of DBCP which did not meet the risk criteria of §162.11(a)(3) for issuance of an RPAR are summarized in Table 13.

B. Human Exposure To DBCP

The next stage in the Agency's assessment of human risks from exposure to DBCP was the identification of the populations with actual or potential exposures to DBCP, and the identification of their routes of exposure. The levels and durations of those exposures were then estimated, and the estimates were used to calculate the potential lifetime exposures of the identified populations.

In the Notice of Intent to Suspend, the Agency used the best data then-available to calculate the exposures from both consumption of DBCP residues by the general United States population, and from inhalation of DBCP vapors by DBCP applicators. The Agency used residue data available from supervised field trials approximating registered uses of DBCP. It also extrapolated that data to predict DBCP residues in related crops (or crops with common growing characteristics) for which there were registered uses of DBCP and for which residue data was absent or inconclusive. No data were then available concerning potential concentrations of DBCP in the air surrounding applicators. However, there were such data for a similar chemical, ethylene dibromide, which is also applied by soil injection. Accordingly, the Agency used a ratio of the vapor pressures of the two compounds to estimate a range of DBCP air concentrations which could reasonably be expected from DBCP soil injection.

The Agency has since received, both in RPAR rebuttal comments and as the result of experiments by or under contract to the Agency, substantial amounts of exposure data on DBCP itself. These new data include: additional residue data from registrants particularly Dow and Shell; inhalation exposure data from agricultural applications of DBCP, from Shell and Dow; air monitoring data of DBCP field applications submitted by the Pineapple Growers Association of Hawaii ("PGAH") as well as a study conducted for PGAH by Dollar & Hertlein (1977) containing additional air monitoring data; a study conducted by the OPP's Chemical and Biological Investigations Branch, which gathered data on the air contamination levels and disappearance rates of DBCP from soil (Hansen, 1977); and a study conducted by Enos _et al_. (1978) at the University of Miami School of Medicine reporting on the development and application of a methodology for environmental sampling to determine DBCP levels in ambient air.

The information referred to above was analyzed by the Chemistry Branch of OPP's Criteria and Evaluation Division, and formed the basis of its "Analysis of Human Exposure to DBCP" (the "Exposure Analysis"). The information in that document was used to estimate the exposures of all affected populations from DBCP use, on a use-by-use basis. These estimates may best be summarized by the four major routes of exposure: ingestion of DBCP residues in food, inhalation of DBCP by applicators and mixers and loaders, inhalation of DBCP after reentry into treated areas, and dermal absorption of DBCP during application, mixing and loading, or spill cleanups. Each of these categories will now be discussed in detail.

(1) _Ingestion of DBCP Residues_

Chemists in the OPP's Registration Division have reviewed all of the available DBCP residue data.

They have concluded that it is reasonable to hypothesize that DBCP itself is not absorbed and translocated within growing plants; rather, residues of DBCP in crops grown in DBCP-treated soil are probably from the crops' contact with the treated soil, from volatilization of DBCP from the treated soil and condensation or absorption on crop surfaces, or from deposition of DBCP on the crop itself during application. They further concluded that root crops, which bear the highest residues, may be exceptions to this hypothesis, especially in light of the demonstrated ability of carrots to absorb organochlorine pesticides from the soil. Based on actual data from supervised trials, or extrapolation of that data to other related crops or crops with similar growing characteristics, the chemists estimated a range of residues that may result from registered DBCP uses (Worthington, 1978a, 1978b; Cummings, 1978). Those data are summarized in Table 12.

Those values are estimates of the range of residues that might result from maximum registered application rates. However, the chemists also noted that actual agricultural practices currently in use are often more restrictive than the registered recommendations (for example, with respect to application rates and preharvest intervals), so that residues which many treated crops may be expected to bear would fall at the bottom of the estimated ranges. Nevertheless, for the purposes of calculating potential exposure to the general population from ingestion of DBCP residues, the upper limits of the estimates ranges have been utilized, and thus represent a worst case situation.

Finally, to calculate an individual's average daily intake of DBCP residues, the maximum residue for each crop was multiplied by the average amount of that crop consumed daily on a per capita basis. That figure was in turn multiplied by the percentage (by acreage) of the national crop treated with DBCP, to get an estimate of exposure potential reflecting actual use patterns. Those factors also are tabulated in Table 12, together with the estimated maximum daily intake of DBCP (on a picogram/kilogram bodyweight/day basis) for each food crop for which DBCP is currently registered.

(2) Inhalation of DBCP By Applicators During Application

Applicator exposure to DBCP, by inhalation, calculated on a use-by-use basis, is summarized in Table 3.

The first step in the calculation was the estimation of DBCP air concentrations during application, on a technique-by-technique basis. The DBCP Exposure Analysis estimated the inhalation exposure on a milligram per hour basis for soil injection (other than pineapple), soil injection (pineapple), irrigation, in-furrow, granular, and drench.

The next step in the inhalation exposure analysis focused on the individual use categories of DBCP. Thus, for each use pattern, the following information was identified or estimated: the application technique(s); the number of applicators and helpers exposed to DBCP; and the number of hours per year that each exposed person might be expected to be exposed to DBCP. This information is tabulated in Table 11, which is exhaustively footnoted with the sources of the data and calculations. The number of applicators exposed, the duration of their exposure, and their dose of DBCP per hour were then entered into the appropriate columns in Table 3, estimates of yearly and lifetime doses of DBCP, per exposed person, were then derived.

Finally, for each technique exposure was calculated for two distinct phases of the overall application process: during mixing and loading operations, and during the actual application. This was done to enable the Agency to evaluate whether different restrictions to prevent or diminish inhalation exposure would be appropriate for the different phases of application. This subject is addressed in detail in Section IV.

(3) Inhalation of DBCP During Reentry Into Treated Areas

There may also be inhalation exposure to DBCP if people reenter treated areas after application of DBCP but before the ambient air concentrations of DBCP have dissipated. Although DBCP is a highly volatile compound, the Agency determined that it was appropriate to measure DBCP disappearance rates in treated soil and in air over treated soil at various intervals after DBCP application by various techniques. That data was evaluated and analyzed in the DBCP Exposure Analysis, and is presented in Table 4.

(4) Dermal Exposure to DBCP

Dermal exposure to DBCP may occur in a variety of situations —for example, during mixing and loading operations, during spill cleanups, during maintenance of application equipment, or during different phases of actual application. Moreover, the subchronic toxicity studies referred to in Section II A indicate that DBCP is apparently readily absorbed through the skin. Indeed, Dow Chemical Company states in its rebuttal comment, "it is reasonable to expect that absorption through the skin may be as significant or, indeed, more significant than inhalation unless precautions to prevent skin contamination are adhered to strictly." (RPAR Comment No. 3A [30000/19], p. 17)

Accordingly, Table 4 contains estimates of potential dermal exposures to DBCP in various contexts. The estimated doses are calculated on a per drop basis, and assume that the entire drop is absorbed through the skin. In fact, it is reasonable to assume that a person will be dermally exposed to much more than a single drop of DBCP in any of the exposure situations described.

C. Determination of Risk

The final stage of the Agency's risk assessment of a pesticide is a prediction of the human health hazards from exposure to the chemical. Based on the toxicological and epidemiological evidence of adverse effects and human exposure estimates, the Agency used, where possible, appropriate mathematical models to quantify the risk. In other circumstances, the Agency was only able to qualitatively describe the risk.

(1) Risk of Cancer

(a) General

The Agency's Cancer Guidelines state that when a chemical is judged to be a potential human carcinogen, the Agency will make estimates of its possible impact on public health at current and anticipated levels of exposure. The Cancer Guidelines also recognize that the available techniques for assessing the magnitude of cancer risk to human populations based on animal data are at best very crude; this is due to uncertainties in the extrapolation of dose-response data to very low dose levels and due to differences in levels of susceptibility of animals and humans. Accordingly, as the Administrator cautioned when he provided preliminary risk estimates in the Notice of Intent to Suspend, the risk estimates are neither scientific certainties nor absolute upper limits on the risks of cancer from continued use of DBCP. Rather, any estimates are used by the Agency as rough approximations of the degree of human cancer risk which may be expected from continued use of DBCP.

(b) Rebuttal Comments to the Risk Assessment

Dow Chemical Company has challenged the validity of the

Agency's approach to quantification of the increased risks of cancer from with exposure to DBCP. Dow asserted that the Agency's risk assessment model is a very conservative one which overestimates the risk, and claimed that application of CAG's model to workmen exposed to 1 ppm DBCP for 10 years would be expected to result in "such a horrendous increase of cancer" among the workers that it would have been detected long ago. Dow also claimed that by applying the model to the data collected in the Dow-Hazleton bioassay (described in Section II A), the model's prediction of risk is significantly greater than the cancer rates actually observed. Finally, Dow asserted that extrapolation of the incidence of stomach cancer incurred via ingestion of DBCP to predict the incidence of cancer via inhalation of DBCP is questionable, since the cancerous effect is likely to be initiated locally (RPAR Comment No. 3A [30000/19]).

In response, the CAG acknowledged the difficulty of predicting the incidence of tumors which might be incurred via one route of administration based on the incidence of tumors observed via a different route of administration. However, the CAG also noted that a target organ can often be affected via more than one route of administration; it referred to a recent skin painting study on Swiss mice (See Section II A, supra) in which DBCP did not induce skin cancer but did induce a high incidence of lung adenoma and squamous cell carcinoma of the forestomach.

Accordingly, the CAG concluded that in the absence of reliable information on inhalation carcinogenesis of DBCP in animals, the CAG's approach must be deemed reasonable and applicable. (Albert, 1978).

With respect to Dow's assertions concerning epidemiologic evidence which would have been uncovered if the CAG's mathematical model were accurate, the CAG acknowledged that it was a valid concern that any mathematical model used to estimate cancer risk might seriously overestimate the true risk. However, the CAG also noted that mere speculations as to what a validly conducted epidemiologic study might reveal cannot be used to invalidate a mathematical model. Rather, for the assertion to have any validity, a well-controlled epidemiologic study with indications of lifetime exposures to DBCP would have to be conducted and made available to the Agency for analysis. (Id.)

Finally, the CAG expressed reservations about using the Dow-Hazleton data as the basis for a risk assessment, because the histopathology for that study had not yet been completed. Nevertheless, a "non-conservative" model, based on the preliminary results of the Dow-Hazleton study, was applied to the exposure data available to the Agency at the time the Notice of Intent to Suspend was issued. Although the estimated risks were generally reduced by about one order of magnitude, the CAG noted that the risks were still of considerable concern. (Id.)

(c) Final Cancer Estimates

The CAG has used the exposure estimates described earlier (See Tables 3,4 and 12) to estimate the risks of cancer from those exposures to DBCP. The CAG has used the same mathematical model as it used in the Notice of Intent to Suspend to estimate the risk via ingestion (i.e., resulting from consumption of DBCP residues in food crops). This was done because the final histopathology for the Dow-Hazleton study has still not been received by the Agency. The probabilities of the occurrence of cancer due to consumption of DBCP residues are listed on a crop-by-crop basis in Table 12.

With respect to the cancer risk from inhalation of DBCP, the CAG noted that for a chemically related compound, EDB, the estimated human risk based on a rat intubation study was higher than the estimated risk based on a human epidemiology study. Although the CAG did not have a human epidemiologic study for DBCP, it used the relative potency of DBCP to EDB to construct a model for estimating the risks from inhalation of DBCP which took that relationship for EDB into account. The resulting estimates are approximately 18.6 times lower than they would have been if only the DBCP rat intubation study had been used. Table 3 presents those estimates of risks for applicator inhalation exposure during application and during mixing and loading operations; Table 4 presents estimates for inhalation exposures to persons reentering treated areas and for inhalation exposure during a spill cleanup.

Finally, for potential dermal exposures to DBCP, the CAG has estimated the risk of cancer from exposure to one drop of DBCP in a lifetime (see Table 4), using a slightly modified version of the mathematical model that was used for ingestion exposure. Although this model may overestimate the risk of cancer from dermal exposure, it must be strongly emphasized that the estimates are based on a lifetime exposure of only one drop of DBCP. Since it may be anticipated that a person handling DBCP carelessly is likely to be dermally exposed to more than a single drop, these estimates must be given considerable weight in terms of regulatory decisions as discussed in Section IV.

(2) Risks of Testicular Toxicity

The Agency has a significant amount of epidemiologic evidence indicating that exposure to DBCP may result in testicular toxicity, as manifested by depressed sperm counts. However, the Agency does not have a model analogous to the CAG cancer model for quantifying any dose-response relationship between DBCP exposure and reductions in sperm counts.

Nevertheless, as discussed earlier, the Agency determined that the risk of a depressed sperm count from exposure to DBCP increased with increased length of exposure to DBCP. This relationship was clear notwithstanding that actual exposure levels could not be precisely quantified. Moreover, the Agency concluded that the data would not support the establishment of a level or length of exposure to DBCP that would not pose any risk of a depressed sperm count.

Accordingly, although the Agency will not now make quantitative estimates of the risk of a depressed sperm count from exposure to DBCP, the Agency does believe that there is the risk of a depressed sperm count from exposure to DBCP, and that the risk increases as the amount of exposure increases. Based on this qualitative criterion and the exposure figures in Tables 3 and 4, it is apparent that: (1) the irrigation method of application presents a significantly greater risk of a depressed sperm count than does the soil injection technique; (2) the drench technique also presents a somewhat greater risk than does the soil injection technique; and (3) all dermal exposures to DBCP present significant risks of a depressed sperm count.

III. Benefits Analysis of DBCP

A. Background

In the Notice of Intent to Cancel, the Administrator summarized the conclusions of the preliminary benefits analysis of DBCP. He noted that there are effective registered alternative pesticides for most uses of DBCP, including most vegetable uses. However, those alternatives are also generally more expensive. Cancellation of DBCP for use on vegetables would thus probably increase control costs by about $15-20 million per year, but without any significant reduction in crop yields, and with only a negligible impact at the consumer level. For use on grapes, peaches and other stone fruits, and citrus, the Administrator noted that although there are effective pre-plant alternatives to DBCP, there are no registered post-plant alternatives. He noted that this may be expected to reduce the life expectancy of affected vineyards, orchards and groves, and to result in short-term losses of about $67 million per year for the first 3 years after cancellation. At the time of issuance of the Notice of Intent to Cancel, analyses of the long-term impacts of cancellation on these and other affected crops were still in progress.

For this Final Position Document, the Agency and the United States Department of Agriculture (USDA) have prepared an economic analysis to quantify, on a use-by-use basis, the potential economic consequences of cancelling all registrations of DBCP for all registered uses. (EAB/AREB, 1978). In this section of the Final Position Document, the Agency has summarized in detail the methodology and process used to prepare the final economic analysis. Since it was impossible to predict with absolute certainty any economic or biological phenomenon, the Agency employed various economic assumptions and models in its analyses, using the Agency's experience and expertise in these areas; they are outlined and explained in detail in the various support documents which are discussed herein. Finally, this section summarizes the major conclusions of the final economic analysis, and provides a background for the specific dollar figures, and the long and short term qualitative impacts, which are discussed in detail in Section V.

B. The Cooperative Assessment

Following the publication of the Administrator's Notice of Intent to Suspend, a DBCP Impact Assessment Team was appointed by the National Pesticide Impact Assessment Steering Committee pursuant to the Memorandum of Understanding between the Agency and USDA. The Assessment Team's membership included representatives from both the Agency and USDA, as well as State Extension Service and research personnel knowledgeable in the field of nematode damage and control. The Assessment Team met in Florida on October 17-21, 1977, to assemble, organize and summarize the available biological data about the major agricultural uses of DBCP.

The Assessment Team's deliberations and conclusions were presented to the Agency in the "USDA/State and EPA Cooperative Assessment of DBCP Uses in Agriculture," dated November 7, 1977, and later designated as Rebuttal Comment No. 17 [30000/19] ("Cooperative Assessment"). The Cooperative Assessment addressed eleven different categories of uses of DBCP: peaches, citrus, grapes, pineapples, soybeans, cotton, peanuts, vegetables (including melons and strawberries), home gardens and lawns, commercial turf, and ornamentals.

For each category, the Cooperative Assessment first identified the major nematode pests of the particular crop or use. It then discussed the DBCP application methods for that crop or use, the rate and frequency of applications, and the availability of chemical alternatives to DBCP for pre-plant, at-plant and post-plant application.

The Cooperative Assessment also examined the feasibility of non-chemical alternative methods of nematode control for each category. The alternatives ranged from crop rotation to resistant varieties of root stock, biological control by predators or natural enemies of the nematodes, and to other cultural practices. Combinations of these methods were also considered as part of an integrated pest management approach.

The Cooperative Assessment then developed an estimate of the economic consequences of a DBCP cancellation for each category. It used available yield and efficacy data, the results of actual use practice, and other relevant published data. When information was not available, Assessment Team members, relying on their collective experience and expertise in the fields of nematology and agricultural practice, developed consensus estimates of yield or quality impacts which would result from the cancellation of DBCP.

The first factor addressed by the Cooperative Assessment for each category was the impact on yield which would result if DBCP were not available. Where there were no registered alternatives for DBCP, as in the case of post-plant applications for peaches, citrus and grapes, the dollar impact of a loss in yield was mitigated to some extent by the savings from not applying DBCP.

The second major element estimated by the Cooperative Assessment for each category was the increased cost of alternative nematicides, assuming that these alternatives would be available. In determining both the allocation of present DBCP usage to alternative chemicals and the usage rates of those alternatives, the Cooperative Assessment relied on such factors as the efficacy of the alternatives, the treatment costs of the alternatives, State recommendations for nematode control, other product labels and Assessment Team members' expertise.

Finally, the Cooperative Assessment predicted that there would be a loss of quality in certain affected crops if DBCP were not available. It also predicted that the longevity of some perennial crops would be reduced if DBCP were not available, and it estimated the magnitude of those reductions.

C. Benefits Analysis

The Cooperative Assessment, and rebuttal comments on the benefits of DBCP, were then reviewed by USDA and Agency economists. Whenever appropriate, the economists also gathered and evaluated additional information about the major crop categories. The economists participated in further communications communications and discussions directly with university, Extension Service or user group personnel; they also conducted additional research into previously published data and agricultural statistics. In addition, the economists gathered information and data on the minor use crops not addressed by the Cooperative Assessment, through communications with nematologists and other experts in the field. Specifically, the economists estimated the impact of cancelling DBCP registrations for use on almonds, apricots, cherries, figs., walnuts, bananas, blackberries, blueberries, loganberries, dewberries, boysenberries, plums, raspberries and eastern nursery stock strawberries.

That review and evaluation formed the basis of the Agency's final analysis of the benefits of DBCP, "Economic and Social Impacts of Cancelling Use of DBCP as a Pesticide for All Registered Use Sites with Known Current Usage" ("Benefits Analysis"). For each major use and for each class or category of minor uses the Benefits Analysis summarizes: the geographical area of use; the major pests controlled; major registered alternative chemicals and non-chemical controls, with comparative evaluations of their efficacy, performance, and cost; the extent of use (in terms of both annual treated acres and quantity of DBCP active ingredient applied annually); and a description of the economic impacts of a DBCP cancellation.

Table 8 summarizes the potential economic impacts of cancelling all registrations of DBCP. The impacts at the user level, expressed as increases in control costs or decreases in yield or both, are presented separately from the impacts at the consumer level, which are generally expressed increased prices. The impacts are also broken down into short-term (up to three years) and long-term (greater than three years) impacts, these are qualitatively assessed (e.g., severe, moderate, negligible) for their overall significance to the entire U.S. production of the crop.

The information and conclusions presented in Table 8 for Benefits Analysis. Each chapter contains the assumptions and methodologies used as well as supporting tables, calculations of the estimates, sources of all data, and a bibliography of references.

D. Major Conclusions

In summary, the Benefits Analysis estimates that the potential short-term impact of cancellation to DBCP users may be as high as $400 million during the first 3 years after cancellation; this is comprised of about $280 million in yield reductions, and about $115 million in increased control costs. Reductions in yield would be most severe in the perennial crops for which there are no registered post-plant alternatives. Indeed, five of these crops -- citrus, grapes, peaches, plums and almonds -- account for about 80% of the projected dollar losses from yield reductions. Increases in control costs, would be most severe for soybeans, accounting for about 58% of the projected dollar increase in control costs. However, only negligible decreases in soybean yields would be expected from such a shift in control chemicals.

The Benefits Analysis also estimates that the short-term impact of cancellation at the consumer level would be increased retail prices for certain commodities. Although the consumer price impact for most commodities would be negligible, the most seriously affected crops would be: peaches (up to 25% increase in retail price); almonds and plums (up to 20%); pineapples (up to 9%); and citrus (up to 5%).

The Benefits Analysis also qualitatively described the anticipated long-term impacts of a DBCP cancellation for each use or category of use. These impacts are difficult to assess because of the large number of variables involved. Factors such as the development, use and availability of new alternative control methods or chemicals, and the potential for greater productivity and increased planting in uninfested areas, are almost impossible to predict. Moreover, price elasticity and demand curves for crops are not always available. Nevertheless, for each major use and for each class or category of minor uses, the Benefits Analysis predicted the long-term impacts of a DBCP cancellation on users and consumers.

Finally, the Benefits Analysis concludes that the macroeconomic (i.e., nationwide) impact on the agricultural economy of a DBCP cancellation would be negligible--in terms of both employment and inflation--notwithstanding the potential severity of the impacts on certain sectors of the agricultural economy. Similarly, it concludes that the average consumer's food budget will not be measurably increased by a DBCP cancellation.

Part V presents a more detailed discussion of the potential impacts of a DBCP cancellation, on a use-by-use basis.

IV. Development and Selection of Regulatory Options

A. Introduction

In Sections II and III, the Agency identified the risks from exposure to DBCP and identified the benefits from each of its uses. As explained in Section I, FIFRA mandates the Agency to to achieve a balance between these competing considerations. To accomplish that goal, the Agency has identified a number of regulatory options, and has evaluated each option for its impacts on both sides of the risk/benefit equation.

This section of the Final Position Document describes how the Agency developed possible regulatory options for evaluation, and identifies six options which were ultimately selected for in-depth evaluation. In Section V of this Final Position Document, each option is evaluated for each registered use of DBCP, and the rationale for final selection of an option for each use is set forth.

B. Rationale for Development of Options

In its simplest terms, FIFRA contemplates two basic options concerning pesticide regulation — namely, to grant or deny registration. For new pesticide products, these options are approval or denial of an application for registration; for previously registered pesticide products, they are a decision to either cancel the registration or to allow the continued registration of the product. Both denial and cancellation of registration represent absolute regulatory responses in that they unqualifiedly prohibit the sale or distribution of the pesticide for the uses at issue. Registration, on the other hand, represents a whole range of regulatory options, since the Administrator may specify the terms and conditions of the registration, including label and labeling language and classification for restricted use.

Cancellation and unrestricted registration fall at opposite ends of the regulatory spectrum. The development of intermediate regulatory options thus involves the formulation of terms and conditions which may be imposed on a pesticide's registration to reduce the risks from the use of the pesticide.

Reduction of risk is achieved by eliminating or minimizing human exposure. Accordingly, after considering the routes of human exposure discussed in Section II, the Agency has developed and considered six methods of reducing both applicator and general population exposures to DBCP: classification of DBCP for restricted use, for use only by certified applicators; reduction of ingestion exposure by elimination of residues of DBCP in food; reduction of dermal exposure by use of protective clothing; reduction of inhalation exposure by use of respirators; reduction of inhalation exposure by establishment of reentry intervals; and reduction of inhalation exposure by prohibition of the irrigation technique of application. Each of these methods will now be discussed and evaluated.

C. Risk Reduction Methods

(1) Classification For Restricted Use

Under FIFRA, hazardous pesticides may be classified for restricted use and be limited to use only by or under the direct supervision of certified applicators who have been determined to be competent to use and handle pesticide products. Certification programs are for the most part administered by the states. These programs use various methods to certify applicators, after a determination that they are competent to use restricted use pesticides.

The Agency believes that the classification of DBCP for restricted use would ensure that it would only be available to competent persons. By preventing untrained growers and homeowners from using DBCP products, the risk of human exposure to DBCP due to misuse or carelessness would be significantly reduced. Moreover, the Administrator has already determined in the Notice of Intent to Suspend that any marginal costs that might result from restriction to certified applicators would be minimal; state programs for the certification of applicators are operational in almost all states, there is a large number of certified applicators, and there is relatively llittle difficulty in obtaining applicator certification.

Accordingly, one regulatory option would be to classify for restricted use all uses of DBCP that are not proposed to be cancelled (or which are not cancelled).

(2) Reduction of Ingestion Exposure

As detailed in Section II, residues of DBCP *per se* may be expected to occur in 19 food crops for which DBCP is presently registered (See Table 12). As explained earlier, the Agency has concluded that these residues probably result from the crops coming into contact with the treated soil; from volatilization of DBCP from the treated soil and condensation or absorption on crop surfaces; or from deposition of DBCP on the crop during application.

The Agency has explored ways to eliminate these residues by controlling the time of application. Specifically, the Agency believes that residues would be significantly reduced (although not precluded) if application of DBCP were prohibited when edible portions of the affected crops were present or would be likely to be present before the DBCP has dissipated. The Agency chemists who reviewed the residue data on DBCP therefore recommended that all post-plant applications of DBCP to the affected food crops be prohibited.

The Agency then conducted a survey of Extension Service and University nematologists. It determined that the impact of post-plant prohibitions on residue reductions would be negligible, since it is already common agricultural practice to use DBCP as a pre-plant or at-plant treatment. (Michell, 1978). However, in light of existing data and scientific uncertainty about the mechanism of formation of DBCP residues, the Agency cannot conclude that prohibition of post-plant applications of DBCP will preclude the possibility of residues occurring in the affected crops.

The Agency must therefore conclude that there is no regulatory restriction which it can reasonably impose that can confidently be expected to eliminate the possibility of DBCP residues.

(3) Reduction of Dermal Exposure

As discussed earlier, dermal exposure to DBCP is of considerable concern to the Agency. It appears that DBCP is readily absorbed through the skin, and Dow Chemical Company has commented that one drop of pure DBCP on the skin could result in an exposure of 1.6 mg/kg body weight (RPAR Comment No. 3A [30000/19]). The CAG has determined that exposure to a single drop of DBCP could result in an increased risk of cancer on the magnitude of 6.5×10^{-4}. Accordingly, it is necessary to explore means for reducing or eliminating all possibility of human dermal contact with DBCP.

Cleanup of DBCP spills and maintenance of application equipment pose the greatest potentials for dermal exposure.

At such times, the Agency believes that it is prudent and necessary to protect all parts of the body from possible DBCP exposures. To do this would require wearing of impermeable gloves, boots or boot covers, helmet, face shield, coat and pants of any of the materials described in Table 7. Since the total cost of such a protective outfit is about one hundred dollars, the Agency has determined that it would be appropriate to require full-body protective clothing at all times during cleanup of a spill and during maintenance of any DBCP application equipment. This rationale is equally applicable to all other exposure situations with high potentials for dermal exposure, including all phases of mixing, loading and transfer operations.

Another means of reducing such dermal exposures is use of closed system equipment for mixing and transfer of DBCP. For other pesticide products (see e.g., EPA Registration Nos. 2139-100 and 100-551), the Agency has defined a closed system to include appropriate connections, meters, pumps and plumbing which are designed to eliminate all human contact with the pesticide. Those registrations also preclude the use of open mixing vats or tanks, or open pouring, and all plumbing connections have to be sufficiently tight to prevent any leakage. Moreover, hoses have to be constructed of chemically resistant, heavy duty, reinforced materials, and transport and storage vessels and transfer equipment have to be equipped with dry-break valves. Since the Agency believes that use of engineering controls to reduce potential human exposures should be encouraged, it has determined that if a closed system of mixing or transfer is used, an impermeable apron may be worn instead of impermeable coat and pants. However, impermeable gloves and boots or boot covers would still have to be worn.

Finally, the Agency has determined that there are moderate to low risks of potential dermal contact with diluted DBCP during application by irrigation, by drench, by in-furrow and by granular formulations. The Agency believes that the potential risks of dermal contact from these application techniques would be significantly reduced or eliminated by a requirement that applicators wear impermeable gloves and boots during the application operations. Since the cost of this equipment is about two dollars per pair of gloves and seven dollars per pair of impermeable boot covers (see Table 7), this equipment would be mandatory during application of DBCP by any of these four techniques.

(4) Reduction of Inhalation Exposure by Use of Respirators or Closed Systems

As detailed in Section II, the degree of exposure to DBCP via inhalation varies significantly from one exposure situation to another. Moreover, it appears that the risks from such exposure are roughly proportional to the overall degree of exposure--i.e., the higher the exposure, the greater the risk. The Agency has therefore explored the feasibility of requiring respirators when the potential for inhalation exposure is of concern.

Table 7 lists the three basic types of generally available respirators (air-purifying, supplied-air, and self-contained breathing apparatus (SCBA)) and their minimum protection factors and approximate cost per item. In determining which type of equipment to require, the Agency took into account the relative costs of the different types of equipment, and also the feasibility and enforceability of their use. Thus, although SCBA and other supplied-air respirators provide much greater protection factors than do air-purifying respirators, they are considerably more expensive than air-purifying respirators, are physically much more limiting, and may require medical examination and monitoring for their use. */ Moreover, the Agency would expect a much higher degree of compliance with an air-purifying respirator requirement--with which many applicators are experienced--than with more burdensome and expensive equipment with which even certified applicators are not likely to be familiar.

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*/ See, for example, subsection (m)(5)(c) of the permanent OSHA standard for occupational exposure to DBCP (29 DBCP (29 CFR § 1910.1044) which requires physicians examining employees pursuant to a medical surveillance program to recommend limitations upon the employees' use of these types of respirators.

Further, the Agency believes that the restriction of DBCP products to certified applicators is likely to reduce the incidence of the highest exposure situation, spill cleanups (likely to be sporadic), and to avoid excessive and undue exposure to a medical surveillance program to recommend limitations upon the employees' use of these types of respirators, during other phases of mixing, loading, transfer, and actual application of DBCP. Accordingly, whenever respirators would be required--during any phase of the mixing, loading and transfer operations, during performance of maintenance upon application equipment, or during application--the Agency has determined that full-face air-purifying respirators would be appropriate.

Another means of reducing inhalation exposure is use of closed system equipment for mixing, transfer or application. The Agency believes that the reduction of potential human exposure through engineering controls should be encouraged. Accordingly, the Agency has determined that if a closed system of mixing, transfer or application is used and results in an airborne concentration of DBCP not exceeding 1 part DBCP per billion parts of air (1 ppb) as an 8-hour time-weighted average -- the OSHA standard for occupational exposure to DBCP -- that a respirator would not have to be worn during the operation of the closed system. However, a respirator would have to be available for use in case of a leak, spill or other unexpected exposure.

(5) Reduction of Inhalation Exposure by Establishment of Reentry Intervals

As discussed in Section II, there may be inhalation exposure to DBCP vapors during reentry into a treated areas. As seen from the figures in Table 4, the potential for exposure decreases with time for all of the application techniques for which data are available. Thus, for the injection technique, DBCP concentrations in the air decrease by a factor of 13 from time of application to 1 day later and by a factor of 46 from time of application to 7 days later. For irrigation, the one day decrease is by a factor of 6; the Agency does not have data for longer periods following application. For drench techniques, the reduction in 1 day is by a factor of approximately 10,000, and the reduction in 3 days is by a factor of approximately 30,000. Finally, for the in-furrow method of application, the available data indicates that there is no significant reduction in air concentrations of DBCP 1 day after application, and a reduction by a factor of 0.2 7 days after application. No data are available to the Agency about application of the granular formulation of DBCP.

The Agency recognizes that the available data on "fall-off" curves for air concentrations of DBCP after application is limited. Nevertheless, the Agency believes that it is prudent and necessary to establish intervals after DBCP application during which reentry to treated areas without a full-face air-purifying respirator would be prohibited. The Agency believes that a 24 -hour interval would be reasonable and would significantly reduce potential inhalation exposures. Therefore, reentry into treated areas would be prohibited for 24 hours after application, unless the person reentering the treated area is wearing a full-face air-purifying respirator.

(6) Reduction of Inhalation Exposure by Prohibition of Irrigation Method of Application

As seen in Table 3, the irrigation method of application poses the highest estimated exposure per hour of all the application techniques, both during mixing and loading and during actual application. Indeed, the hourly exposure during mixing and loading is approximately 25 times higher than the hourly exposure during mixing and loading for the injection technique; and the hourly exposure during actual application is 100 times higher than the hourly exposure during actual application by the injection technique. The Agency evaluated the feasibility of prohibiting the irrigation method by determining whether growers could switch to an alternative method of application, soil injection. There are three advantages to growers who are currently using the irrigation technique*/ : the cost of application is almost zero since DBCP treatment is performed in conjunction with routine irrigation; unlike injection, irrigation does not cause mechanical injury to tree or vine roots; and unlike injection, irrigation does not disrupt operations which have adopted no-till weed control systems (Luttner, 1978).

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*/ The affected crops are peaches, plums, almonds and grapes in California and citrus in California, Texas and Arizona.

The Agency also estimated that for those growers who could change to soil injection using their own equipment (estimated to cost $200), the increased cost of application would be from $6 to $10 per acre. For those growers who would have to hire custom applicators, the cost could be as high as $35 per acre.

The Agency concluded that it is reasonable to assume that many growers, especially citrus growers, would discontinue use of DBCP if forced to use the injection technique, the increased costs of DBCP treatment would decrease the margin of revenue return from DBCP treatment, and there will be possible root damage and disruptions in other operations. For these growers, prohibiting the irrigation technique would be tantamount to cancelling DBCP for those uses. However, many other growers would be forced into absorbing higher applicator costs, especially where post-plant DBCP application is essential to maintain economic levels of production. Those growers may also use reduced application rates and longer treatment intervals to decrease DBCP application costs, and may then also have to accept lower production and revenues. However, the Agency was not able to accurately project how many growers would discontinue use of DBCP altogether.

In summary, the Agency has determined that prohibition of the irrigation method of application would be an appropriate option, to be considered on a use-by-use basis, to reduce applicator inhalation exposure to DBCP.

D. Regulatory Options Selected

From the full range of available restrictions and regulatory options discussed, the Agency has selected six options for the ultimate registration decision. In Part V, each options will be considered and evaluated for each use of DBCP to determine whether its adoption would achieve adequate risk reduction without significant impacts on the benefits of the use.

In developing these options the Agency started by choosing both the least restrictive option -- continued registration as a general use pesticide without additional regulatory restrictions -- and the most restrictive option -- cancellation. The Agency then attempted to define intermediate options. The first option includes the minimum restrictions necessary to significantly reduce at least some exposures to DBCP; the remaining three options each cumulatively add additional restrictions to further reduce exposure. In selecting these options, the Agency necessarily exercised its discretion in its choice and consideration of options, since it is virtually impossible to evaluate every conceivable option or combination of options. In the aggregate, however, the Agency believes that its choice of options fully and adequately addresses all relevant exposure concerns about the use of DBCP.

The options selected are:

(1) Continue registrations without additional restrictions

Under this option, a use of DBCP would be registered in the same manner and with the same restrictions that existed before the Notice of Intent to Suspend. In other words, no additional regulatory action would be taken to reduce any risk from DBCP use.

(2) Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance and clean-up; require boots and gloves during application.

This option would reduce the potential for exposure, especially dermal exposure, in several situations.

First, the use of DBCP would be limited to certified applicators (or persons under their direct supervision) who have been demonstrated to be competent to use and handle DBCP; this would generally reduce the risks which may result from carelessness or misuse.

Next, full-body protective clothing and a full-face air-purifying respirator would be required during all phases of mixing and transfer operations, during maintenance (including calibration) of application equipment, and during clean-up of spills or accidents. The full-body protective clothing would consist of impermeable gloves, boots or boot covers, coat and pants; it would significantly reduce the high potential for dermal exposure during these operations. Although it would also be appropriate to require a helmet and face-shield as part of the protective clothing, the Agency believes that requiring the use of a full-face air-purifying respirator would be even more appropriate; this would also reduce the potentially high inhalation exposures during these operations in addition to protecting against dermal exposure. If a closed system for mixing or transfer is used, an impermeable apron, gloves and boots or boot covers would be required. If a closed system is used which results in an airborne concentration of DBCP not exceeding 1 part DBCP per billion parts of air (1 ppb) as an 8-hour time-weighted average, then a respirator would not have to be worn during the operation of the closed system, but would have to be available for use in case of leaks, spills or other emergencies.

Finally, to reduce potential dermal exposures during actual application, impermeable gloves and boots or boot covers would be required during all phases of application using the irrigation, drench, granular and in-furrow techniques.

(3) Option (2) plus: require a respirator and re-entry interval for irrigation applications

This option would include all of the restrictions and conditions of option (2), and would also require the use of a full-face air-purifying respirator during all phases of application by irrigation. This would reduce the potential for inhalation exposure from the application technique posing the highest hourly inhalation exposure. Further, this option would also reduce the potential inhalation exposure of persons reentering treated areas, by prohibiting reentry for 24 hours after the completion of irrigation unless the persons reentering were to wear a full-face air-purifying respirator and impermeable gloves boots or boot covers.

(4) Option (2) plus: require a respirator and reentry interval for all application techniques

This option would also include all of the restrictions and conditions of option (2), and would further reduce the potential for inhalation exposure by requiring a full-face air-purifying respirator during all phases of all applications by all techniques. This option would also reduce the potential inhalation exposure of persons reentering treated areas, by prohibiting reentry for 24 hours after completion of application unless the persons reentering were to wear a full-face air-purifying respirator, and, in the case of irrigation or drench application, impermeable gloves and boots or boot covers.

(5) Option (4) plus: prohibit application by irrigation

This option is the most restrictive option short of cancellation. It would incorporate all of the restrictions and conditions of option (4) -- which in turn incorporates the restrictions and conditions of option (2) -- and would also prohibit all applications by the irrigation technique. This option completely eliminates the high inhalation and dermal exposure potentials of the irrigation technique, and the inhalation and dermal exposure potentials of all other techniques would be minimized.

(6) Cancel registrations

Under this option, a specific use of DBCP would be prohibited and all risks from that use of DBCP would be completely eliminated.

V. Review of the Impacts of the Major Options

This section evaluates, on a use-by-use basis, the impacts of each regulatory option developed in Section IV. In assessing each option, the Agency determined the reductions in risks which would be achieved and considered how the risk reduction measures would affect the benefits of the use.

All information necessary for this evaluation has been described in Sections II and III, with the exception of one important area--namely, information concerning the risks from the use of pesticides which would be used if DBCP were unavailable. To provide these data, the Agency has generated three support documents. A memorandum of human hazards, "Toxicology Data on Alternative Pesticides to DBCP," details all published and proprietary data concerning those alternatives (Dale, 1978b). The significant acute and chronic toxic effects of each substitute chemical were derived from this document and presented in another memorandum, "Summary Tables for DBCP" (Sandusky, 1978).

A "Fish and Wildlife Risk Analysis" evaluated all the potential effects on terrestrial and aquatic organisms (Bushong, 1978). Sufficient data were not available to perform a full, detailed risk assessment for any of the substitute pesticides. However, the available acute and chronic toxicity data, field studies and incidents, wildlife label warnings and the rates of application were described for most of the substitutes. In a few instances possible significant wildlife losses or dieoffs which could occur from the use of a substitute at the recommended application rates were pointed out.

All hazards of concern--both human and environmental--from potential use of the substitute pesticides are listed in Table 5 and are discussed in detail for each use in this section. Table 9 contains estimates of the percent increased use of the substitutes to indicate the magnitude of the potential hazards of concern.

For each use a standard format is followed: (1) Usage data--the total amount of DBCP applied, total acres treated, the predominant techniques of application and any available substitute methods of nematode control; (2) Risk data--the primary routes of human exposure, the number of people involved and the risks to individuals; (3) Benefits data--the advantages of DBCP over other methods of control and the impacts that would result if DBCP were not available; (4) Impacts Analysis--the adverse and beneficial impacts of the options on human health, the environment and various economic sectors; (5) Alternative Chosen--the final course of action and the rationale for choosing it.

A. Citrus

(1) Usage

DBCP is the only registered nematicide for postplant control of nematodes on all varieties of citrus trees.

About 1,292,000 pounds are applied annually to 31,200 acres in Texas, Florida, California and Arizona (Benefits Analysis). Since the material is applied once every 3 years, a total of 93,600 acres or 7.9% of domestic citrus acreage are treated. Soil injection and irrigation are the only application methods. Their use varies by state (see Table 11).

(2) Risks

Since no residues of DBCP are expected in citrus, the only risks are to 593 pesticide applicators. As summarized in Table 3, the risks from inhalation during application vary considerably by state and by application technique. For injection, the risk of cancer ranges from a lifetime probability 1.31×10^{-5} in California to a probability of 2.63×10^{-4} in Florida; for irrigation, the cancer risk ranges from 5.11×10^{-3} in California and Arizona to 8.72×10^{-2} in Texas. The risks from inhalation during mixing and loading also vary by state and by application technique. For injection, the risk of cancer ranges from a lifetime probability of 3.32×10^{-6} in California to a probability of 6.57×10^{-5} in Florida; for irrigation, the risk ranges from 3.07×10^{-4} in California and Arizona to 5.48×10 in Texas. A risk of adverse reproductive effects for male applicators accompanies the cancer risk.

Table 4 summarizes risks from other potential exposure situations.

(3) Benefits

The value of DBCP to citrus may be expressed in terms of the adverse economic impacts of the unavailability of DBCP. Fresh and process orange production would be reduced by 4.60% and 0.17%, respectively, after 3 years. Fresh grapefruit, lemon and tangerine production would be reduced by 6.03%, 9.77% and 3.81% respectively per year at the end of 3 years. The total value of reduced production on the affected acreage would be $29,092,000. Subtracting the cost of control with DBCP, the net grower level impact in reduced revenues during the three-year period is $26,851,000 (Benefits Analysis).

In the long term, the greatest impact would be reduced tree longevity. With DBCP, grove life is about 60 years; without DBCP, groves would remain productive only 30 to 40 years. This would necessitate replanting and 4 years of unproductive acreage at an earlier than normal time. These production reductions would increase retail citrus prices: fresh oranges, 3.83%; process orange products, 0.23%; fresh grapefruit, 4.94%; lemons and tangerines, an undetermined but probable increase.

The long-term impacts would be severe for affected growers and moderate for consumers and the citrus industry.

(4) Regulatory Options and Their Impacts

Option 1: Continue registrations without additional restrictions.

(i) Adverse Impacts - The risks to 593 applicators would continue.

(ii) Beneficial Impacts - The nematode control advantages of DBCP would continue.

Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations; and require boots and gloves during application.

(i) Adverse Impacts - The risks from inhalation exposure to DBCP during application would continue. The costs of requiring protective equipment, including respirator, would be $110 per person in the affected operations.

(ii) Beneficial Impacts - DBCP use by untrained persons would be eliminated. The risks from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. Risks to applicators from inhalation exposure during mixing and loading, spill cleanups, *etc*. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 30 minutes per day, a practice with which most persons may be expected to comply. The nematode control advantages of DBCP would continue.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation.

(i) Adverse Impacts - There would still be some risks, one-fiftieth that described in the citrus risk discussion,. from inhalation exposure during irrigation. The risks from inhalation exposure during soil injection would continue. The costs of imposing these restrictions would be $110, the same as in Option 2.

(ii) Beneficial Impacts - There would be the same beneficial impacts as in Option 2, but the risks from inhalation exposure during irrigation would be reduced at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after irrigation would be reduced. The nematode control advantages of DBCP would continue.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques.

(i) Adverse Impacts - There would still be some risks, at one-fiftieth the level described in the citrus risks discussion, from inhalation exposure during application. The costs of imposing these restrictions would be $110, as in Option 2.

(ii) Beneficial Impacts - These would be the same as in Option 2, but in addition the risks to applicators from inhalation exposure during all applications would be decreased at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after all applications would be reduced. The nematode control advantages of DBCP would continue.

Option 5: Option 4 plus prohibit application by irrigation.

(i) Adverse Impacts - Most of the 716 growers*/ in California, Texas and Arizona who had been using irrigation would probably not be willing to switch to soil injection; they could minimally maintain economic production without DBCP, since revenues and returns would be significantly reduced and since there would be root damage and disruption of no-till weed control. If all growers stopped using DBCP, the total impact would be $21,800,000. For the growers who continue the use DBCP via soil injection, the cost of application would be about $8 per acre if they applied it themselves, or as high as $35 per acre if they hired a custom applicator. If all growers switched to injection, the total impact would be $190,000-$830,000 per 3 years on 23,700 acres, or $265-$1160 per grower per year cycle (Luttner, 1978) These growers or custom applicators would also be subject to the same risks described in Option 4.

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*/ 716 is the total number of farmers who grow citrus on acres that are treated with DBCP (See Table 11). The 593 persons cited previously are those who actually apply DBCP. In Texas, only 20 persons apply DBCP on the farms of 303 growers. This accounts for the difference between 716 and 593.

(ii) Beneficial Impacts - The high risks from inhalation and dermal exposures during and after irrigation would be completely eliminated, and the risks from inhalation during soil injection would be reduced at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after soil injection would be reduced. The nematode control advantages of DBCP would continue.

Option 6: Cancel registrations.

(i) Adverse Impacts - Significant adverse economic impacts would occur as described in citrus benefits.discussion.

(ii) Beneficial Impacts - All risks associated with the use of DBCP would be eliminated.

(5) Regulatory Option Selected

Option 1 is rejected, because without further restrictions this use of DBCP will result in unreasonable adverse effects on the environment. The Agency has selected Option 4, since it will adequately reduce risks without significant impacts on the benefits of this use. Options 2 and 3 will not satisfactorily reduce risk and will result in unreasonable adverse effects. Options 5 and 6 will reduce or eliminate the risks of DBCP, but will result in unacceptable adverse impacts on the economic benefits of this use. Thus, in order to continue a registration of DBCP on citrus, the conditions of registration must be modified as described in Option 4.

B. Cotton

(1) Usage

Each year 2,700,000 pounds of DBCP are applied pre-, at- or post-plant at a rate of 12.1 pounds per acre to 225,000 acres, or 2% of all planted acres (Benefits Analysis). It is applied most commonly pre-plant by soil injection.

EDB, Telone II and D-D are the most viable, registered substitutes. Under ideal conditions they control nematodes on cotton. They cost more per acre and require a 10- to 14-day delay in planting in order to avoid phytotoxicity (Benefits Analysis).

(2) Risks

The only risks from use on cotton are for 1,271 applicators in the South.

The increased probability of cancer from inhalation during application is 7.76×10^{-5} (Table 3). The increased probability of cancer from inhalation during mixing and loading is 2.01×10^{-5}, Simultaneously, there is an increased risk of decreased sperm counts for exposed males.

Table 4 summarizes the risks from other potential exposure situations.

(3) Benefits

The value of DBCP to cotton growers is estimated at $2,600,000 per year. This figure is based on the cost of substitute chemicals and on the assumption that those pesticides are as efficacious as DBCP. This impact is very small as compared to the total farm value of cotton of $3,100,000,000 in 1976; consequently, this impact would not be expected to significantly affect total cotton production or consumer prices (Benefits Analysis).

(4) Regulatory Options and Their Impacts

Option 1: Continue registrations without additional restrictions.

(i) Adverse Impacts - The risks to 1,271 applicators would continue.

(ii) Beneficial Impacts - The nematode control advantages of DBCP would continue.

Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations; and require boots and gloves during application.

(i) Adverse Impacts - The risks from inhalation exposure to DBCP during application would continue. The costs of requiring protective equipment, including respirator, would be $175 per person in the affected operations.

(ii) Beneficial Impacts - DBCP use by untrained persons would be eliminated. The risks from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. Risks to applicators from inhalation exposure during mixing and loading, spill cleanups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 30 minutes per day, a practice with which most persons may be expected to comply. The nematode control advantages of DBCP would continue.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation.

(i) Adverse Impacts - These would be the same as in Option 2, since no DBCP is known to be applied by irrigation.

(ii) Beneficial Impacts - These would be the same as in Option 2, since no DBCP is known to applied by irrigation. However, if DBCP were applied by irrigation, the risks to applicators from any inhalation exposure would be decreased fiftyfold. Risks to persons reentering a treated area would be reduced at least sixfold.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques.

(i) Adverse Impacts - There would still be some risks, one-fiftieth of that described in the cotton risks discussion, from inhalation exposure during application. The costs of imposing these restrictions would be $175 as in Option 2.

(ii) Beneficial Impacts - These would be the same as in Option 2; in addition the risks to applicators from inhalation exposure during all applications would be decreased at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after soil injection would be reduced. The nematode control advantages of DBCP would continue.

Option 5: Option 4 plus prohibit application by irrigation.

(i) Adverse Impacts - These would be the same as in Option 4, since no DBCP is known to be applied by irrigation.

(ii) Beneficial Impacts - Same as for alternative 2, since no DBCP is known to applied by irrigation. However, if DBCP were applied by irrigation, the risks to applicators from any inhalation exposure would be eliminated. Risks to persons reentering a treated area would also be eliminated.

Option 6: Cancel registrations.

(i) Adverse Impacts - There would be minor long and short-term impacts for growers and consumers: $3,300,000 per year in control cost increases for growers and up to 0.1% price increases for consumers. There may be some risks to applicator from the increased use of substitute pesticides (see Tables 5 and 9).

There may be some chronic risks to applicators from increased use of the substitute pesticides DD, EDB and Telone

II (see table 5). About 9,200,000 pounds of DD, 950,000 pounds of EDB and 4,300,000 pounds of Telone II might be used annually in place of DBCP. These amounts are 130%, 13% and 62%, respectively, of the amounts of these chemicals produced in the United States in 1974 or 1975. Thus, the chronic risks to applicators from use of these substitutes only on cotton might be substantial.

(ii) Beneficial Impacts - All risks from the use of DBCP would be eliminated.

(5) Regulatory Option Chosen

Option 1 is rejected, because without further restrictions this use of DBCP will result in unreasonable adverse effects on the environment. The Agency has selected Option 4, since it will adequately reduce risks without significant impacts on the benefits of this use. Options 2 and 3 will not satisfactorily reduce risks and will result in unreasonable adverse effects. Options 5 and 6 will eliminate the risks of DBCP, but will result in unacceptable adverse impacts on the economic benefits of this use and will create significant potential risks from use of substitute nematicides. Thus, in order to continue a registration of DBCP on cotton, the terms and conditions of registration must be modified as described in Option 4.

C. Grapes

(1) Usage

DBCP is an integral part of nematode control programs for vineyards. Other fumigants are used for pre-plant treatment; DBCP is applied post-plant 2 to 5 years later if nematode populations return to damaging levels. These post-plant treatments are applied at 1 to 3 year intervals thereafter, usually by flood irrigation, but sometimes by injection. Rates of application range from 2.86 to 3.57 gallons of DBCP per acre (12.1 pounds a.i. per gallon) (Benefits Analysis).

In California, where 90% of grapes in the U.S. are grown, about 165,000 acres or 31% of the total bearing acres are treated subject to treatment. Based on an average application rate of 39 lbs. a.i./acre, the total use of DBCP is 3,200,000 pounds annually or 6,400,000 pounds for a two-year treatment cycle.

There are no effective Federally registered nematocides that could substitute for DBCP postplant nematode control in vineyards.

(2) Risks

Only 2,320 growers applying DBCP by irrigation and 258 growers applying it by soil injection.are at risk. For irrigation applicators, inhalation exposure during application poses 5.48 X 10^{-3} increased probability of cancer; during mixing and loading, the cancer risk from inhalation is 3.54 X 10^{-4} (table 3). For soil injection applicators, inhalation of DBCP during application poses 1.57 X 10^{-5} increased probability of cancer; during mixing and loading their risks of cancer are increased by 4.02 X 10^{-6} For males in both groups, there is a risk of reduced sperm counts. The risks from other potential exposure situations are summarized in Table 4.

(3) Benefits

Since there are no registered alternative nematicides for grapes, the value of DBCP to growers in California is substantial. If DBCP were unavailable, there would be severe reductions in grape production and revenues would decline $64,700,000 for the first 3 years. Vineyard life would be reduced from 30-60 years to 10-15 years.

While individual grower impacts cannot be determined for all varieties of grapes and soil types, one example illustrates the economic implications to table grape growers if DBCP is not available. For the first year, Thompson Seedless table grape producers would suffer reduced revenues of $161 per acre, assuming 10% yield reduction, constant prices and 100% nematode infestation. A representative producer with 74 acres would therefore lose about $12,000 in revenue, or 5.2% of gross revenue (Benefits Analysis).

In the short term, consumers would pay higher prices as grape production falls, especially for table grapes, since most of the table grape acreage is treated for nematodes. In the long term, consumers might be faced with smaller supplies and up to a 5% price increase. Total production would be likely to stabilize at near "normal" levels as new production procedures, resistant varieties or new nematicides were developed.

(4) Regulatory Options and Their Impacts

Option 1: Continue registration without additional regulatory restrictions.

(i) Adverse Impacts - The risks to 2,578 applicators would continue.

(ii) Beneficial - The nematode control advantages of DBCP would continue.

Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations; and require boots and gloves during application.

(i) Adverse Impacts - The risks from inhalation exposure to DBCP during application would continue. The costs of requiring protective equipment, including respirator, would total $110 per person in the affected operations.

(ii) Beneficial Impacts - DBCP use by untrained persons would be eliminated. The risks to all applicators from dermal exposure to DBCP would be virtually eliminated by the protective clothing. The risks to applicators from inhalation exposure during mixing and loading, spill cleanups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 30 minutes per day, a practice with which most persons may be expected to comply. The nematode control advantages of DBCP would continue.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation.

(i) Adverse Impacts - There would still be some risk, at one-fiftieth the level described in the grapes risk discussion, from inhalation exposure during irrigation. The risks from inhalation exposure during soil injection would continue. The costs of imposing these restrictions would be $110, as in Option 2.

(ii) Beneficial Impacts - These would be the same as in Option 2; in addition, the risks from inhalation exposure during irrigation would be reduced at least fiftyfold. The risks from inhalation exposure during reentry into treated areas following irrigation would also be reduced. The nematode control advantages of DBCP would continue.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques.

(i) Adverse Impacts - There would still be some risks from inhalation exposure during application, at one-fiftieth the level described in the grapes risk discussion. The costs of imposing these restrictions would be $110, the same as in Option 2.

(ii) Beneficial Impacts - These would be the same as in Option 2, but the risks from inhalation exposure during irrigation would be reduced at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after irrigation would also be reduced. The nematode control advantages of DBCP would continue.

Option 5: Option 4 plus prohibit application by irrigation.

(i) Adverse Impacts - The 2,320 growers who had been using irrigation would be forced to switch to soil injection to maintain economic levels of production. If all growers applied DBCP themselves, the cost of application would increase $8 per acre, a total of $594,000 every 3 years, $256 per grower. If the DBCP were applied by commercial applicators, the costs would be $35 per acre, a total of $2,600,000 every 3 years, or $1120 per grower. The risk to applicators would be the same as in Option 4. The costs of protective equipment would be $110 per person. If all growers did not switch to injection, the total impact would be about $58,500,000. Although soil injection can cause some root damage, most growers would probably switch, since DBCP is necessary for economic production.

(ii) Beneficial Impacts - The high risks from inhalation and dermal exposure during and after irrigation would be completely eliminated, and the risks from inhalation during soil injection would be reduced at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after soil injection would be reduced. The nematode control control advantages of DBCP would continue.

Option 6: Cancel registrations.

(i) Adverse Impacts - There would be severe short and long term impacts on growers, as described earlier in the grape benefits discussion. Consumers will be significantly affected for the short term and moderately affected for the long term.

(ii) Beneficial Impacts - All risks from the use of DBCP would be eliminated.

(5) Regulatory Option Chosen

Option 1 is rejected, because without further restrictions this use of DBCP will result in unreasonable adverse effects on the environment. The Agency has selected Option 4, since it will adequately reduce risks without significant impacts on the benefits of this use. Options 2 and 3 will not satisfactorily reduce risks and will result in unreasonable adverse effects. Options 5 and 6 will eliminate the risks of DBCP, but will result in unacceptable adverse impacts on the economic benefits of this use. Thus, in order to continue a registration of DBCP on grapes, the conditions of registration must be modified as described in Option 4.

D. Peaches and Nectarines

(1) Usage

DBCP may be applied pre- and post-plant to control nematodesin peach and nectarine orchards. In California and several Eastern states, about 327,000 pounds are used annually in new orchard plantings, or 44% of the total acreage planted per year. In the East, about 871,000 pounds are applied post-plant to 24,000 acres over a two-year cycle. In California, about 3,180,000 pounds are applied postplant to 65,700 acres over a three-year period (Benefits Analysis).

The standard application techniques are soil injection in the Eastern states and irrigation in California. The respective application rates are 7 gallons per acre and 3.5 to 5 gallons per acre (12 lbs a.i. per gallon).

DBCP is the sole registered nematicide for post-plant treatment of nematodes in peach orchards. Likely alternatives for pre-plant applications are EDB, D-D and Telone.

(2) Risks

Only to 1,714 applicators in the East and 1,095 applicators in California are at risk from DBCP use on peaches and nectarines. The cancer risk to California growers from inhalation exposure during irrigation is 5.48×10^{-3}; during mixing and loading, the cancer risk is 2.08×10^{-4}. For Eastern growers, the risk from inhalation exposure during application by soil injection is 5.11×10^{-6} increased probability of cancer; from inhalation exposure during mixing and loading, the increased risk of cancer is 3.36×10^{-6}. For all male applicators there is a risk of decreased sperm counts. Risks from all other potential exposure situations are summarized in Table 4.

(3) Benefits

The unavailability of DBCP would have immediate cost impacts due to higher costs for pre-plant alternatives and would lead to major reductions in peach production on affected acres in subsequent years due to the lack of post-plant substitutes. For pre-plant nematode control, growers would spend an additional $673,000 per year for pre-plant nematode control. The unavailability of DBCP for post-plant aplications would significantly reduce production and result in a total loss of $40,161,000 over the initial three years following cancellation. This is a worst-case estimate, since projected crop losses would lead to higher market prices, thereby offsetting to some extent the reduced revenue (Benefits Analysis).

Without an effective post-plant nematicide the average peach tree life would be reduced from 12-13 years to 6-7 years in the East and from 20 to 10 years in California. Chronically infested orchards areas would be converted to use for other crops; new peach tree lands would be developed to the extent that uninfested land was available and economically feasible. Peach producers not affected by a loss of DBCP would probably have higher returns; they would probably intensify production practices and increase plantings. However, affected growers would be severely impacted, and related industries (e.g., peach processors) might be forced to shift to other commodities.

Consumers would pay up to 25% higher retail prices for fresh and processed peach products in the short-term. For the long term, factors such as production increases by growers in unaffected areas or the introduction of an effective post-plant nematicide could lower peach prices to "normal" levels.

(4) Regulatory Options and Their Impacts

Option 1: Continue registrations without additional restrictions.

(i) Adverse Impacts - The risks to 1,714 applicators would continue.

(ii) Beneficial Impacts - The nematode control advantages of DBCP would continue.

Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations; and require boots and gloves during application.

(i) Adverse Impacts - The risks from inhalation exposure to DBCP during application would continue. The costs of requiring protective equipment, including respirator, would be $110 per person in the affected operations.

(ii) Beneficial Impacts - DBCP use by untrained persons would be eliminated. The risks from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. The risks to applicators from inhalation exposure during mixing and loading, spill cleanups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 30 minutes per day, a practice with which most persons may be expected to comply. The nematode control advantages of DBCP would continue.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation.

(i) Adverse Impacts - There would still be some risks, at one-fiftieth the level described in the peach risk discussion, from inhalation exposure during irrigation. The risks from inhalation exposure during soil injection would continue. The cost of imposing these restrictions would be $110, the same as in Option 2.

(ii) Beneficial Impacts - These would be the same as in Option 2, in addition to which the risks from inhalation exposure during irrigation would be reduced at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after irrigation would also be reduced. The nematode control advantages of DBCP would continue.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques.

(i) Adverse Impacts - There would still be some risks at one-fiftieth the level described in the peach risk discussion, from inhalation exposure during application. The cost of imposing these restrictions would be $110, the same as in Option 2.

(ii) Beneficial Impacts - These would be the same as in Option 2, but the risks to applicators from inhalation exposure during all applications would be decreased at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after all applications would be reduced. The nematode control advantages of DBCP would continue

Option 5: Option 4 plus prohibit application by irrigation.

(i) Adverse Impacts - The 1,095 growers who had been using irrigation would be forced to switch to soil injection to maintain economic levels of production. If all growers applied DBCP themselves, the cost of application would increase $8 per acre, a total of $175,000 every 3 years, or $160 per grower. If the DBCP were applied by commercial applicators, the costs would be $35 per acre, a total of $767,000 every 3 years, or $700 per grower. The risk to applicators would be the same as in Option 4. The costs of protective equipment would be $110 per person. If all growers did not switch to injection, the total impact would be about $52,000,000. Although soil injection can cause some root damage, most growers would probably switch, since DBCP is necessary for economic production.

(ii) Beneficial Impacts - The high risks from inhalation and dermal exposure during and after irrigation would be completely eliminated, and the risks from inhalation during soil injection would exposure during reentry into treated areas after soil injection would be reduced. The nematode control advantages of DBCP would continue.

Option 6: Cancel registrations.

(i) Adverse Impacts - There would be severe short- and long-term adverse economic impacts as described in the peach benefits discussion.

There may be some chronic risks to applicators from increased pre-plant use of the substitute pesticides DD, EDB and Telone II (Table 5). About 1,400,000 pounds of DD, 500,000 pounds of EDB and 1,00,000 pounds of Telone might be applied in place of DBCP (Table 9). These amounts are 20%, 7% and 16%, respectively, of the amounts of these chemicals produced in 1974 or 1975. Thus, there might be a moderate degree of chronic risk to applicators from the use of these substitutes on peaches and nectarines.

(ii Beneficial Impacts - All risks from DBCP would be eliminated.

(5) Regulatory Option Chosen

Option 1 is rejected, because without further restrictions this use of DBCP will result in unreasonable adverse effects on the environment. The Agency has selected Option 4, since it will adequately reduce risks without significant impacts on the benefits of this use. Options 2 and 3 will not satisfactorily reduce risks and will result in unreasonable adverse effects. Options 5 and 6 will eliminate the risks of DBCP, but will result in unacceptable adverse impacts on the economic benefits of this use. Thus, in order to continue a registration of DBCP on peaches and nectarines, the conditions of registration must be modified as described in Option 4.

E. Peanuts

(1) Usage

About 3,200,000 pounds of DBCP are applied annually to 355,000 acres throughout nine peanut-producing states. Generally, DBCP is applied 6 to 8 inches deep by chisel injection at a rate of 9 pounds a.i. per acre (Benefits Analysis).

Alternative fumigants are EDB, Telone II and D-D. The most practicable registered granular alternatives are Carbofuran, Mocap and Dasanit. However, all of these are less efficacious against some or all nematode species, are less efficacious under some soil moisture conditions, and all are more expensive.

(2) Risks

The increased risk of cancer to the U.S. population from residues in food is 3.26 X 10^{-5}, or 103 cases per year. There is also a risk of decreased sperm counts for men. Also at risk are 7,397 applicators. The risk from inhalation of DBCP during application is 2.63 X 10^{-5} increased probability of cancer; from inhalation exposure during mixing and loading, this risk is 6.57 x 10^{-6}. There is also a risk of decreased sperm counts for men. Table 4 summarizes the risks from all other potential exposure situations.

(3) Benefits

The grower impact of the unavailability of DBCP would be $6,800,000 per year in production losses and from the increased control costs of substitute chemicals. After 3 years, the total impact would be $19,500,000. The greatest impacts would occur in Oklahoma and Texas, where about 10% of the peanut growers there (i.e., 648) would have negative returns and would be forced to grow other crops (Benefits Analysis).

Peanut growers in Oklahoma and Texas could suffer severe impacts which might force them out of business. Producers would have to consider alternative farm enterprises. In the other regions, producers' returns would decrease if DBCP were not available, but returns would still be positive. The total impact of the unavailability of DBCP on all growers would be minor.

The loss of DBCP would have a minimum impact on consumers, since most if not all of any price increase would be offset by a decrease in price support payments (Benefits Analysis).

(4) Regulatory Options and Their Impacts

Option 1: Continue registration without additional restrictions.

(i) Adverse Impacts - The risks to the U.S. population from consumption of DBCP residues would continue and the risks to 7,397 applicators would continue.

(ii) Beneficial Impacts - The nematode control advantages of DBCP would continue.

Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations; and require boots and gloves during application.

(i) Adverse Impacts - The risks to the U.S. population from consumption of DBCP residues would continue. The risks from inhalation exposure to DBCP during application would continue. The cost of requiring protective equipment, including respirator, would be $110 per person in the affected operations.

(ii) Beneficial Impacts - DBCP use by untrained persons would be eliminated. The risks to all applicators from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. The risks to applicators from inhalation exposure during mixing and loading, spill cleanups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 30 minutes per day, a practice with which most persons may be expected to comply. The nematode control advantages of DBCP would continue.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation--Not applicable.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques.

(i) Adverse Impacts - The risks to the U.S. population from consumption of DBCP residues would continue. There would still be some risk, at one-fiftieth the level described in the peanut risk discussion, from inhalation exposure during application. The cost of imposing these restrictions would be $110, the same as in Option 2.

(ii) Beneficial Impacts - These would be the same as in Option 2, but the risks to applicators from inhalation exposure during all applications would be decreased at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after soil injection would be reduced. The nematode control advantages of DBCP would continue.

Option 5: Alternative 4 plus prohibit application by irrigation--Not applicable.

Option 6: Cancel registrations

(i) Adverse Impacts - There would be minor adverse economic impacts, except on growers in Texas and Oklahoma, who would sustain major losses (see peanut benefits discussion). There would be risks from substitute pesticides.

There may be some chronic risks to applicators from increased use of the substitutes DD, EDB and Telone II. There may also be some acute risks to wildlife from increased use of Carbofuran, Dasanit, Mocap and Nemacur (Table 5). In place of DBCP, 1,300,000 pounds of DD, 6,900,000 pounds of EDB, 1,100,000 pounds of Telone, 48,000 pounds of Carbofuran 48,000 pounds of Dasanit, and 200,000 pounds of Mocap and 200,000 pounds of Nemacur might be used (Table 9). These amounts are 18%, 95%, 16%, 1%, 1%, 20% and (unknown)% of the amounts of these chemicals produced in 1974 or 1975. Thus, chronic risks to applicators might be substantial, while the acute risks to wildlife might be moderate.

(ii) Beneficial Impacts - All risks from DBCP will be eliminated.

(5) Regulatory Option Chosen

Option 1 is rejected, because this use of DBCP will result in unreasonable adverse effects on the environment. The Agency has selected Option 6, since it will eliminate risks from DBCP, while only adversely affecting 10% of the peanut growers in Texas and Oklahoma; it will also result in some potential risks from use of substitute nematicides. Options 2 and 4 will not satisfactorily reduce risk and will result in unreasonable adverse effects. Thus, the Agency has determined that all registrations of DBCP for peanuts must be cancelled in order to prevent unreasonable adverse effects.

F. Pineapple

(1) Usage

The only state in which pineapples are commercially produced is Hawaii. About 300,000 pounds of DBCP are used on 5,000 acres per year at a rate of 60.5 pounds a.i. per acre. Since affected acres are treated every 3 years, a total of 15,000 acres may be treated (Benefits Analysis).

About 98% of DBCP applied to pineapples is applied by soil injection to a depth of 8 to - 12 inches. in combination with D-D or Telone. Plastic mulch is laid over the planting rows immediately after injection, behind the injection shanks, to seal in the fumigant. This theoretically results in less exposure to DBCP than would result from the standard soil injection technique without the plastic mulch (Exposure Analysis).

The only registered alternative to DBCP is EDB.

(2) Risks

The only risks are to approximately eight fumigant supply truck drivers who handle the mixing and loading of DBCP and about 68 persons who work on or around the soil injection equipment during application.

Truck drivers, who are exposed to 0.22 mg/hr via inhalation during 8.5 hours per year, have an increased risk of cancer of 2.74×10^{-5}. For equipment operators, hydraulic operators, supervisors and mulch operators involved in the application operation, exposure to 0.013 mg/hr for an average of 338 hours year results in an increased probability of cancer of 6.57×10^{-5}. All exposed men risk a decreased sperm count. Table 4 summarizes risks from other potential exposures.

(3) Benefits

Without DBCP, growers would have to spend $200,000 more per year to apply EDB and would lose $5,800,000 after 3 years due to decreased production. The total impact would be a 9.3% decrease in grower revenue over 3 years. Eventually, the annual yield loss would lead to an increase in prices that would partially or even completely offset decreased grower revenues. Because of the structure of the industry (two of three major growers are also processors), any long-term impact cannot be accurately estimated (Benefits Analysis).

In the short term, consumers might expect up to a 9% increase in prices.

(4) Regulatory Option and Their Impacts

Option 1: Continue registration without additional restrictions.

(1) Adverse Impacts - The risk to 76 persons would continue.

(ii) Beneficial Impacts - The nematode control advantages of DBCP would continue.

Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations; and require boots and gloves during application.

(i) Adverse Impacts - The risks from inhalation exposure to DBCP during application would continue. The costs of requiring protective equipment, including respirator, would be $110 per person in the affected operations.

(ii) Beneficial Impacts - DBCP used by untrained trained persons would be eliminated. The risks from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. The risks to truck drivers from inhalation exposure during mixing and loading, spill cleanups, etc. would be reduced at least fiftyfold. They would have to wear full protective clothing for only about

15 minutes per day, a practice with which most persons may be expected to comply. The nematode control advantages of DBCP would continue.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation.

Not applicable.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques.

(i) Adverse Impacts - There would still be some risk from inhalation exposure during application, at one-fiftieth the the level described in the pineapple risk discussion. The costs of imposing these restrictions would be $110, the same as in Option 2.

(ii) Beneficial Impacts - These would be the same as Option 2, but the risks to applicators from inhalation exposure during all applications would be decreased at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after soil injection would be reduced. The nematode control advantages of DBCP would continue.

Option 5: Option 4 plus prohibit application by irrigation--Not applicable.

Option 6: Cancel registrations.

(i) Adverse Impacts - There would be minor to severe economic impacts as described earlier in the pineapple benefits discussion. There are no known environmental risks from using EDB as a substitute. However, several chronic hazards are associated with this chemical, namely oncogenicity, mutagenicity and adverse reproductive effects. These risks are being evaluated through the RPAR review process at this time. In place of DBCP, 720,000 pounds of EDB would be applied every 3 years.

(ii) Beneficial Impacts - All risks from the use of DBCP would be eliminated.

(5) Regulatory Option Chosen

Option 1 is rejected, because without further restrictions this use of DBCP will result in unreasonable adverse effects on the environment. The Agency has selected Option 4, since it will adequately reduce risks without significant impacts on the benefits of this use. Option 2 will not satisfactorily reduce risks and will result in unreasonable adverse effects. Option 6 will eliminate the risks of DBCP, but will result in unacceptable adverse impacts on the economic benefits of this use and will create significant potential risks from use of the substitute EDB. Thus, in order to continue a registration of DBCP on pineapples, the conditions of registration must be modified as described in Option 4.

G. Soybeans

(1) Usage

DBCP may be applied preplant or at-planting by chisel injection 6 to 8 inches below the surface at a rate of 9 to

12 pounds a.i. per acre, (Cooperative Assessment). In 1976, 12,378,000 pounds were applied to 1,100,000 acres, 5% of all soybean acres planted in the Southeastern and Delta states. (Benefits Analysis). The most practicable substitute pesticides are D-D, Telone, Mocap and Nemacur.

(2) Risks

9,655 applicators are at risk. Inhalation exposure during mixing and loading may result in 1.86 X 10^{-5} increased probability of cancer. Inhalation during application would result in 6.94 X 10^{-5}increased probability of cancer. All exposed men would risk a decreased sperm count. Risks from other potential exposures are summarized in Table 4.

(3) Benefits

If DBCP were not available, the use of substitutes would cost an average of $22 more per acre, or $2,600,000 per year. This impact represents about 0.1% of the $3,000,000,000 farm value of soybeans (Benefits Analysis). On the other hand, about 6,600 growers in the Delta region would sustain a 44% reduction in returns, and 3,000 growers in the Southeast would lose 36% of their returns. Thus, farmers with a severe nematode problem might forced to grow other crops.

There would be only a negligible increase in prices for consumers in the short and long term.

(4) Regulatory Options and Their Impacts

Option 1: Continue registrations without additional restrictions.

(i) Adverse Impacts - The risks to 9,655 applicators would continue.

(ii) Beneficial Impacts - The nematode control advantages of DBCP would continue.

Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations; and require boots and gloves during application.

(i) Adverse Impacts - The risks from inhalation exposure to DBCP during application would continue. The costs of requiring protective equipment, including respirator, would $110 per person in the affected operations.

(ii) Beneficial Impacts - DBCP used by untrained persons would be eliminated. The risk from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. Risks to applicators from inhalation exposure during mixing and loading, spill cleanups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing only for about 30 minutes per day, a practice with which most persons may be expected to comply. The nematode control advantages of DBCP would continue.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation--Not applicable.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques.

(i) Adverse Impacts - There would still be some risks, at one-fiftieth the level described earlier in the soybean risk discussion, from inhalation exposure during application . The cost of imposing these restrictions would be $110 as in Option 2.

(i) Beneficial Impacts - These would be the same as in Option 2, in addition to which the risks to applicators from inhalation exposure during all applications would be decreased at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after soil injection would be reduced. The nematode control advantages of DBCP would continue.

Option 5: Option 4 plus prohibit application by irrigation--Not applicable.

Option 6: Cancel registrations.

(i) Adverse Impacts - While the economic impact of cancellation is insignificant (<0.1% of the value of the soybean production in the United States), growers who use DBCP would be affected significantly, as described in the soybean benefit discussion.

There may be some chronic risks to applicators from increased use of the substitutes DD and Telone II (Table 5). Also, there may be some acute risks to wildlife from increased use of Mocap and Nemacur. In place of DBCP 62,000,000 pounds of DD, 41,000,000 pounds of Telone II, 1,500,000 pounds of Mocap and 340,000 pounds of Nemacur might be used (Table 9). These amounts are 884%, 594%, 153% and (unknown)% of the amounts of these chemicals produced in 1974 or 1975. Thus, chronic risks to applicators and acute risks to wildlife from use of these substitutes might be very substantial.

(ii) Beneficial Impacts - All risks associated with use of DBCP would be eliminated.

(5) Regulatory Options Chosen

Option 1 is rejected, because without further restrictions this use of DBCP will result in unreasonable adverse effects on the environment. The Agency has selected Option 4, since it will adequately reduce risks without significant impacts on the benefits of this use. Option 2 will not satisfactorily reduce risks and will result in unreasonable adverse effects. Option 6 will eliminate the risks of DBCP, but will result in unacceptable adverse impacts on the economic benefits of this use and will create significant potential risks from use of substitute nematicides. Thus, in order to continue a registration of DBCP on soybeans, the terms and conditions of registration must be modified as described in Option 4.

H. Commercial Vegetables, Melons and Strawberries

(1) Usage

DBCP is registered for use on 22 annual or semi-annual vegetable and fruit crops--broccoli, brussel sprouts, cabbage, carrot, cauliflower, celery, cucumber, eggplant, endive, lettuce, lima bean, melons, okra, parsnip, peppers, radish, snap bean, southern pea, tomato, turnip and strawberry. Of these DBCP uses, 19 have be unconditionally suspended (see Table 13). About 3,392,000 pounds per year were applied to 374,000 acres of these crops during 1974-1976. Nationwide the percentage of each crop treated varied from <0.1% for strawberries and several other crops, to 95% for okra (Benefits Analysis).

Usually DBCP is injected 6 inches deep into the soil. If granules are used, they are spread on the soil surface and immediately incorporated with tillage equipment. Rates vary from 6 to 24.2 pounds a.i. per acre (Cooperative Assessment).

The practicable alternative pesticides are EDB, DD, Vorlex and Telone II. However, in some crops in some locations, no alternative pesticide is effective.

(2) Risks

The major source of risk to the general public is consumption of 18 of the crops which may be expected to contain DBCP residues after treatment (Table 2). As shown in this table, the maximum lifetime risk of cancer range from 1.09 X 10^{-8} for brussel sprouts to 4.36 X 10^{-4} for carrots. These risks translate into a total risk of approximately 1905 cases of cancer per year, with carrots accounting for about 68% of that number. There is also a risk of decreased sperm counts for males who would consume DBCP residues.

A total of about 8,272 applicators are also at risk. The number of growers and the hours per year of exposure vary by state (see Table 11). As shown in Table 3, the cancer risk to the 200 applicators in California from inhaling DBCP during application are 6.21 X 10^{-4}; their risk from inhalation during mixing and loading is 1.61 X 10^{-4}. In Florida, the risk to 709 applicators from inhaling DBCP during application is 2.37 X 10^{-5}; their risk from inhalation during mixing and loading is 6.21 X 10^{-5}. In all other states, the cancer risk to 7,400 applicators from inhaling DBCP during application is 6.94 X 10^{-5}; their risk from inhalation during mixing and loading is 1.86 X 10^{-5}. All exposed men would also risk reduced sperm counts. Risks from other potential exposure situations are summarized in table 4.

(3) Benefits

At $6.00 per acre for material costs, DBCP is the most economical method of controlling nematodes in vegetables. The material cost per acre for the alternative nematicides ranges from $9.17 for EDB to $48.00 for Vorlex. If DBCP were not available growers would have to pay $7,730,000 per year more for the cost of alternative materials and the labor to apply them. On acreage where alternatives would not be effective, growers would suffer $6,760,000 losses in production. Thus, the total short term impact would be $14,500,000 per year or $43,400,000 after 3 years. Compared to the value of all affected vegetables, this is a minor impact (Benefits Analysis).

On a per acre basis, the potential losses to growers would range from $13 per acre for cucumbers to $136 per acre for celery. The impacts of this range might lower returns enough to force growers to switch to other crops. As these adjustments are made, the price of the affected vegetables might rise, shifting the cost to the consumer. It is estimated that such an increase would not exceed 0.1% overall (Benefits Analysis).

(4) Regulatory Options and Their Impacts

Option 1: Continue registrations without additional restrictions.

(i) Adverse Impacts - The risks to the U.S. population from consumption of DBCP residues in 18 of 22 crops would continue as would the risks to 8,272 applicators.

(ii) Beneficial Impacts - The nematode control advantages of DBCP would continue.

Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations; and require boots and gloves during application.

(i) Adverse Impacts - The risks to the U.S. population from consumption of DBCP residues in 18 of 22 crops would continue. The risks from inhalation exposure to DBCP during application would continue. The cost of requiring protective equipment, including respirator, would be $110 per person in the affected operations.

(ii) Beneficial Impacts - DBCP used by untrained persons would be eliminated. The risks from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. The risks to applicators from inhalation exposure during mixing and loading, spill cleanups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 30 minutes per day, a practice with which most persons may be expected to comply. The nematode control advantages of DBCP would continue.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation--Not applicable.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques.

(i) Adverse Impacts - The risks to the U.S. population from consumption of DBCP residues in food in 18 of 22 crops would continue. There would still be some risk at one-fiftieth the level described in the vegetable risk discussion, from inhalation exposure during application. The cost of imposing these restrictions would be $110 as in Option 2.

(ii) Beneficial Impacts - These would be the same as Option 2, but the risks to applicators from inhalation exposure during all applications would decrease by a minimum factor of fifty. The risks from inhalation exposure during reentry into treated areas after soil injection would be reduced. The nematode control advantages of DBCP would continue.

Option 5: Option 4 plus prohibit application by irrigation--Not applicable.

Option 6: Cancel registrations.

(i) Adverse Impacts - There would be minor adverse economic impacts on growers and negligible impacts on consumers. There will be some risks from increased use of substitute chemicals (see Tables 5 and 9).

There maybe some chronic risks to applicators from increased use of the substitutes DD, EDB, Telone II and Vorlex 13,000,000 pounds of DD, 3,000,000 pounds of EDB, 5,000,000 pounds of Telone and 340,000 pounds of Vorlex might be used in place of DBCP (Table 9). These amounts are 181%, 41%, 72% and 120%, respectively, of the amounts of these chemicals produced in 1974 or 1975. Thus, the chronic risks to applicators from use of these substitutes on commercial vegetables might be substantial.

(ii) Beneficial Impacts - All risks from the use of DBCP would be eliminated.

(5) Regulatory Option Chosen

Option 1 is rejected, because this use of DBCP will result in unreasonable adverse effects on the environment. The Agency has selected Option 6 for 18 of the 22 crops, since this option will eliminate risks from DBCP, especially to the U.S. population from consumption of DBCP residues in food; at the same time, it will have some adverse health effects for about 8,100 growers from DBCP exposure and result in some potential risks from use of substitute nematicides. Options 2 and 4 will not satisfactorily reduce risk and will result in unreasonable adverse effects. Thus, the Agency has determined that in order to prevent unreasonable adverse effects all registrations of DBCP must be cancelled effects for these crops: broccoli, brussel sprouts, cabbage, carrots, cauliflower, celery, cucumbers, eggplant, endive, lettuce, melons, parsnips, peppers, radishes,squash, tomatoes, turnip and strawberry (except strawberry nursery stock). The Agency has also determined that in order to continue a registration of DBCP on the four crops which do not have in food residues (i.e., lima bean, okra, snap bean and southern pea), the terms and conditions of registration must be modified as described in Option 4.

I. Commercial Turf

(1) Usage

Almost all DBCP turf use is on golf courses (Benefits Analysis). In Florida, South Carolina, Georgia and Texas, golf course turf planted on sandy soils are heavily damaged by nematodes, especially where a course is used heavily. DBCP, the most effective treatment, is injected 3 to 6 inches into established turf at 24-36 pounds a.i. per acre (Cooperative Assessment). From conversations with knowledgeable USDA Extension Service personnel, it is estimated that 11,900 acres are treated annually by custom applicators and 6,600 acres are treated annually by golf course superintendents in Florida, Georgia, South Carolina and Texas (see Footnotes m and o to Table 1). Assuming an average application rate of 30 lb/A, it can be estimated that about 555,000 pounds of DBCP were applied in 1976 (30 lb/A X 18,500 A = 555,000 lbs).

Mocap and Nemacur are the most likely alternative registered pesticides. They are more expensive, less efficacious and must be applied twice a year.

(2) Risks

The population at risk is 11 custom applicators and 199 golf course superintendents. The increased cancer risk for the custom applicators is 5.11×10^{-4} from inhalation exposure during application and 1.35×10^{-4} from inhalation during mixing and loading. For golf course superintendents, the increased risk of cancer is 5.11×10^{-5} from inhalation exposure during application and 1.35×10^{-5} from inhalation during mixing and loading. For all exposed males, there is also a risk of decreased sperm count. Table 4 summarizes the risks from other potential exposure situations.

(3) Benefits

DBCP is the only nematicide which controls most nematodes on turf for more than 2 to 3 months. If DBCP were unavailable, the substitutes Mocap or Nemacur would have to be applied twice a year, will cost much more than DBCP and will control nematodes less well (Cooperative Assessment). Although the Benefits Analysis did not quantify the cost impact of using these substitutes, the Cooperative Assessment arrayed the comparative per acre costs of materials: DBCP, $24-$56; Nemacur, $85-$140; Dasanit, $85-$140; and Mocap, $140-$210. Thus, the cost of the substitute materials range from $60 to $150 more per acre than DBCP. Multiplying these prices by two applications per year and by the total acres treated, the total impacts would range from $2,200,000 to $5,600,000 for all affected areas. Since 310 golf courses may be affected, the average net impact of using the substitute materials would be between $7,000 and $18,000 per course per year.

The Cooperative Assessment concludes that at these high costs it would be impossible to treat fairways, in which case the untreated turf would die. Only ample irrigation, additional fertilizer and increased use of herbicides would prevent total loss of the turf (Smart, 1978a). If putting greens only were treated with a substitute nematicide, the net increased costs of substitute materials would be about $250 to $300 per year per golf course (Bottlinger, 1978).

Increased treatment costs may be passed on to the consumer (i.e., the golfer or club member). Further, where alternatives are not or cannot be used, the aesthetic appearance of a golf course would be adversely affected (Benefits Analysis).

(4) Regulatory Options and Their Impacts

Option 1: Continue registrations without additional restrictions.

(i) Adverse Impacts - Risks to 210 applicators would continue.

(ii) Beneficial Impacts - The nematode control advantages of DBCP would continue.

Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations; and require boots and gloves during application.

(i) Adverse Impacts - The risks from inhalation exposure to DBCP during application would continue. The cost of requiring protective equipment, including respirator, would be $110 per person in the affected operations.

(ii) Beneficial Impacts - DBCP use by untrained persons would be eliminated. The risks from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. The risks to applicators from inhalation exposure during mixing and loading, spill cleanups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 30 minutes per day, a practice with which most persons may be expected to comply. The nematode control advantages of DBCP would continue.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation--Not applicable.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques.

(i). Adverse Impacts - There would still be some risks at one-fiftieth the level described in the commercial turf benefits discussion, from inhalation exposure during application. The cost of imposing these restrictions would be $110 as in Option 2.

(ii) Beneficial Impacts - These would be the same as in Option 2, but in addition the risks to applicators from inhalation exposure during all applications would be decreased at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after soil injection would be reduced. The nematode control advantages of DBCP would continue.

Option 5: Option 4 plus prohibit application by irrigation--Not applicable.

Option 6: Cancel registrations

(i) Adverse Impacts - There would be significant adverse economic consequences for affected golf courses, most of which are in Florida. There would be some acute environmental hazards from the use of the granular alternatives. There maybe some acute risks to wildlife from increased use of the substitutes Mocap and Nemacur (Table 5). In place of DBCP 230,000 pounds of Mocap and 130,000 pounds of Nemacur might be used (Table 9). These amounts are 23% and (unknown)% of the amounts of these chemicals produced in 1974 or 1975. Thus, acute risks to wildlife from use of these chemicals on golf courses might be moderate.

(ii) Beneficial Impacts - The risks from DBCP use would be eliminated.

(5) Regulatory Option Chosen

Option 1 is rejected, because without further restrictions this use of DBCP will result in unreasonable adverse effects on the environment. The Agency has selected Option 4, since it will adequately reduce risks without significant impacts on the benefits of this use. Option 2 will not satisfactorily reduce risks and will result in unreasonable adverse effects. Option 6 will eliminate the risks of DBCP, but will have in unacceptable adverse impacts on the economic benefits of this use and will create some potential risks from use of substitute nematicides. Thus, in order to continue a registration of DBCP on turf on golf courses, the terms and conditions of registration must be modified as described in Option 4.

J. Strawberry Nursery Stock

(1) Usage

The only strawberry nursery stock (i.e., plants grown for transplanting rather than immediate fruit production) known to be treated with DBCP is grown on 625 acres in Maryland and Delaware, where DBCP is applied in accordance with the requirements of the States' strawberry plant certification programs. Basically, the programs call for two to three post-plant side-dressing chisel applications, the first 4 to 6 weeks after planting, the second 10 to 12 weeks after planting and the third, if necessary, 14 to 16 weeks after planting. The rate of application is 1 gallon DBCP or 12.1 pounds a.i. per acre. No alternative nematicides are effective for postplant control of nematodes on strawberry nursery stock (Benefits Analysis).

(2) Risks

With only four farms growing strawberry plants for transplant, it is assumed that there are four applicators exposed to DBCP. For the single applicator in Delaware, the risk from inhalation exposure during application is 2.63×10^{-4} increased probability of cancer; from inhalation exposure during mixing and loading the risk is 6.56×10^{-5} increased probability of cancer. For the three applicators in Maryland, the risk from inhalation exposure during application are 1.06×10^{-4} increased probability of cancer; from inhalation exposure during mixing and loading the risk is 2.56×10^{-5} probability of cancer. All exposed males risk decreased sperm counts. Table 4 summarizes risks from other potential exposure situations.

(3) Benefits

If DBCP were cancelled, strawberry nurserymen in Maryland and Delaware would be seriously affected in the short-term, and possibly forced out of production. Significant but localized community and social disruptions would be likely for nursery employees, since alternative employment opportunities are limited. Gross receipts from strawberry plant sales in Maryland exceed $1,500,000 per year and provide considerable economic stimulus to the area. The situation in Delaware is likely to be similar (Benefits Analysis).

In the long term, without an effective postplant nematicide, production of strawberry plants would shift to other areas. Production of certified plants in Delaware and Maryland might cease. Higher returns in unaffected areas would stimulate production on new or existing acreages. Unaffected growers would benefit from increased sales and higher product prices. Thus, income redistribution to other states may offset some losses in Maryland and Delaware.

Commercial and home growers in the East would be moderately affected as quality strawberry plant supplies become increasingly short 3 to 5 years following cancellation. Consumers would experience some retail strawberry price increases in markets supplied by Eastern berry producers.

Since states east of the Rockies produce only 18% of U.S. strawberry tonnage, and since Maryland and Delaware account for 60% of the planting stock for the Eastern states, the overall U.S. retail price increases would be moderate. In the long term, consumer prices would return to precancellation production expands in unaffected areas (Benefits Analysis).

(4). Regulatory Options and Their Impacts

(a) Option 1: Continue registrations without additional restrictions.

(i) Adverse Impacts - The risks to 4 applicators would continue.

(ii) Beneficial Impacts - The nematode control advantages of DBCP would continue.

(b) Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup opreations; and require boots and gloves during application.

(i) Adverse Impacts - The risk from inhalation exposure to DBCP during application would continue. The cost of requiring protective equipment including respirator would be $110 per person in the afffected operations.

(ii) Beneficial Impacts - DBCP use by untrained persons would be eliminated. The risks from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. The risks to applicators from inhalation exposure during mixing and loading, spill cleanups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 30 minutes per day, a practice with which most persons may be expected to comply. The nematode control advantages of DBCP would continue.

(c) Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation--Not applicable.

(d) Option 4: Option 2 plus require a respirator and reentry interval for all application techniques.

(i) Adverse Impacts - There would still be some risks at one-fiftieth the level described in the strawberry risk discussion, inhalation exposure during application. The cost of imposing these restrictions would be $110, the same as in Option 2.

(ii) Beneficial Impacts - There would be the same as in Option 2, but the risks to applicators from inhalation exposure during all applications would be decreased at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after soil injection would be reduced. The nematode control advantages of DBCP would continue.

Option 5: Option 4 plus prohibit application by irrigation--Not applicable.

Option 6: Cancel registrations

(i) Adverse Impacts - There would be severe short and long term adverse economic effects on strawberry plant producers in Maryland and Delaware. Consumers in the East would pay higher prices for the short term, although the nationwide average would probably not significantly increase.

(ii) Beneficial Impacts - All risks from the use of DBCP would be eliminated.

(5) Regulatory Option Chosen

Option 1 is rejected, because without further restrictions this use of DBCP will result in unreasonable adverse effects on the environment. The Agency has selected Option 4, since it will adequately reduce risks without significant impacts on the benefits of this use. Option 2 will not satisfactorily reduce risks and will result in unreasonable adverse effects. Option 6 will eliminate the risks of DBCP, but will result in unacceptable adverse impacts on the economic benefits of this use. Thus, in order to continue a registration of DBCP on strawberry nursery stock, the conditions of registration must be modified as described in Option 4.

K. Other Berries

(1) Usage

Other berries for which DBCP is registered include blackberries, blueberries, boysenberries, dewberries, loganberries, and raspberries. However, DBCP has been used to a significant extent only on boysenberries and raspberries, in the amount of 25,000 pounds and 67,000 pounds of DBCP per year, respectively (Benefits Analysis). The primary method of application is post-plant soil injection. No effective postplant alternative methods of nematode control are available.

(2) Risks

Because the only known use of DBCP on other berries is on boysenberries and raspberries, risks have only been estimated for these two crops.

About 300 applicators are estimated to be at risk. From inhalation exposure during application the increased probability of cancer is 2.63×10^{-6}. From inhalation exposure during mixing and loading, males have a risk of reduced sperm count. Table 4 summarizes other potential exposure situations.

(3) Benefits

Without DBCP, boysenberry production could initially decline by 10%-15% in California. However, in Oregon and Washington, where most U.S.boysenberries are produced, DBCP is only minimally important to production (Benefits Analysis). In affected areas, production losses would continue at 5%-8% per year. Severely affected areas would probably go out of production, but would be probably replaced to some extent by new plantings in unaffected areas. Consumers could expect some short term retail price increases of 5% - 7% if production losses were to be passed along in corresponding price increases. Long term effects are likely to diminish if new plantings in unaffected areas are brought into production. Thus, long term effects would probably be minimal.

For raspberries, U.S. production is concentrated in Oregon and Washington. There, only 7.3% of the 6,860 acres benefit from DBCP treatments. Without DBCP, there would be a $150,000 loss in production over 3 years. This loss is only 1.8% of the total U.S. crop value. In the long run, affected acres would probably be treated with a preplant fumigant. Some severely infested acres may go out of production and revert to the best alternative crop. Higher returns to unaffected growers and increased planting in unaffected areas would probably offset this loss. Consumers would pay slightly higher retail prices for the short term, but in the long term, prices would be expected to return to near precancellation levels (Benefits Analysis).

For all remaining berries, the major production regions are in Oregon and Washington. Contacts with Extension Service nematologists in these states revealed very limited use of DBCP. Some isolated instances of production losses could occur, but no major shifts in the quantity or geographical area of production would be expected. Market and consumer effects would be minimal for the short and long term.

(4) Regulatory Options and Their Impacts

Option 1: Continue registrations without additional restrictions.

(i) Adverse Impacts - The risk to 300 applicators would continue.

(ii) Beneficial Impacts - The nematode control advantages of DBCP would continue.

Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations; and require boots and gloves during application.

(i) Adverse Impacts - The risks from inhalation exposure to DBCP during application would continue. The costs of requiring protective equipment, including respirator, would be $110 per person in the affected operations.

(ii) Beneficial Impacts - DBCP use by untrained persons would be eliminated. The risks from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. The risks to applicators from inhalation exposure during mixing and loading, spill cleanups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 15 minutes per day, a practice with which most persons may be expected to comply. The nematode control advantages of DBCP would continue.

Option 3: 2 plus require a respirator and reentry interval for application by irrigation

(i) Adverse Impacts - These would be the same as for Option 2, since no DBCP is known to be applied by irrigation.

(ii) Beneficial Impacts - These would be the same as for Option 2, since no DBCP is known to applied by irrigation. However, if DBCP were applied by irrigation, the risks to applicators from any inhalation exposure would be decreased fiftyfold. Risks to persons reentering a treated area would be reduced at least sixfold.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques.

(i) Adverse Impacts - There would still be some risk, at one-fiftieth the level described in the berry risk discussion, from inhalation exposure during application. The costs of imposing these restrictions would be ($110), the same as in Option 2. Homeowners would not likely be willing to buy and use this equipment.

(ii) Beneficial Impacts - These would be the same as in Option 2, but also the risks to applicators from inhalation exposure during all applications would be decreased at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after soil injection would be reduced. The nematode control advantages of DBCP would continue.

Option 5: Option 4 plus prohibit application by irrigation.

(i) Adverse Impacts - These would be the same as for Option since no DBCP is known to be applied by irrigation.

(ii) Beneficial Impacts - These would be the same as for Option 2, since no DBCP is known to be applied by irrigation. However, if DBCP were applied by irrigation, the risks to applicators from any inhalation exposure would be eliminated. Risks to persons reentering a treated area would also be eliminated.

Option 6: Cancel registrations.

(i) Adverse Impacts - There would be some localized adverse impacts as described in the berry benefits discussion.

(ii) Beneficial Impacts - All risks from DBCP use would be eliminated.

(5) Regulatory Option Chosen

Option 1 is rejected, because without further restrictions this use of DBCP will result in unreasonable adverse effects on the environment. The Agency has selected Option 4, since it will adequately reduce risks without significant impacts on the benefits of this use. Options 2 and 3 will not satisfactorily reduce risks and will result in unreasonable adverse effects. Options 5 and 6 will reduce or eliminate the risks of DBCP, but will have unacceptable adverse impacts on the economic benefits of this use. Thus, in order to continue a registration of DBCP on raspberries and boysenberries, the terms of registration must be modified as described in Option 4.

L. Plums

(1) Usage

DBCP is currently applied to a total of 22,000 acres of domestic plums, about 70% of California plantings. About 9,300 acres are treated with 452,000 pounds of DBCP per year. Applications are post-plant by irrigation every 18 to 36 months, depending on the degree of infestation. No effective substitute method of postplant nematode control is available (Benefits Analysis).

(2) Risks

450 applicators are at risk. Inhalation exposure during application and mixing and loading results in increased cancer risks of 3.43×10^{-3} and 2.08×10^{-4}, respectively. All exposed males have a risk of decreased sperm count. Table 4 summarizes risks from other potential exposure situations.

(3) Benefits

If DBCP were unavailable, all treated orchards would begin to be affected by the end of 3 years. Decreases in value of production minus the cost of treatment with DBCP would total $13,754,000 for that period. Severely infested orchards (38% of California acres) would go out of production within 3 to 5 years. Moderately infested acreage (32% of California acres) would remain in production for a longer period. In the long term, plum production might begin in areas not subject to infestation. Higher returns would be expected to stimulate intensified production and increased planting by unaffected growers. Both effects would offset to some extent the production reductions in the affected areas (Benefits Analysis).

For consumers, short term retail price increases of up to 20% are possible. However, since plums represent a minor part of food consumption, the overall consumer impact is negligible. In the long term, production and retail prices might return to normal if new plum plantings in uninfested areas are developed and come into production.

(4) Regulatory Options and Their Impacts

Option 1: Continue registration without additional restrictions.

(i) Adverse Impacts - The risks to 450 applicators would continue.

(ii) Beneficial Impacts - The nematode control advantages of DBCP would continue.

Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations; and require boots and gloves during application.

(i) Adverse Impacts - The risks from inhalation exposure to DBCP during application would continue. The costs of requiring protective equipment, including respirator, would be $110 per person in the affected operations.

(ii) Beneficial Impacts - DBCP use by untrained persons would be eliminated. The risks from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. The risks to applicators from inhalation exposure during mixing and loading, spill cleanups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 30 minutes per day, a practice with which most persons may be expected to comply. The nematode control advantages of DBCP would continue.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation.

(i) Adverse Impacts - There would still be some risk, at one-fiftieth the level describved in the plum risk discussion, from inhalation exposure during irrigation. The costs of imposing these restrictions would be $110, as in Option 2.

(ii) Beneficial Impacts - These would be the same as in Option 2, in addition to which the risks from inhalation exposure during irrigation would be reduced at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after irrigation would also be reduced. The nematode control advantages of DBCP would continue.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques-- This Option is the same as Option 3, since all acres are treated by irrigation.

(e) Option 5: Option 4 plus prohibit application by irrigation.

(i) Adverse Impacts - The 450 growers who had been using irrigation would be forced to switch to soil injection to maintain economic levels of production. If all growers applied DBCP themselves, the cost of application would increase $8 per acre, a total of $75,000 every 3 years, or $166 per grower. If the DBCP were applied by commercial applicators, the costs would be $35 per acre, a total of $327,000 every 3 years, or $726 per grower. The risks to applicators would be the same as in Option 4. The costs of protective equipment would be $110 per person. If all growers did not switch to injection, the total impact would be about $13,800,000. Although soil injection can cause some root damage, most growers would probably switch, since DBCP is necessary for economic production.

(ii) Beneficial Impacts - The high risks from inhalation and dermal exposures during and after irrigation would be completely eliminated, and the risks from inhalation during soil injection would be reduced at least fifty-fold. The risks from inhalation exposure during reentry into treated areas following soil injection would be reduced. The nematode control advantages of DBCP would continue.

(f) Option 6: Cancel registrations.

(i) Adverse Impacts - There would be some localized adverse economic impacts as described in the plum benefits discussion.

(ii) Beneficial Impacts - All risks from DBCP use would be eliminated.

(5) Regulatory Option Chosen

Option 1 is rejected, because without further restrictions this use of DBCP will result in unreasonable adverse effects on the environment. The Agency has selected Option 4 (which is the same as Option 3), since it will adequate by reduce risks without significant impacts on the benefits of this use. Option 2 will not satisfactorily reduce risks and will result in unreasonable adverse effects. Options 5 and 6 will eliminate the risks of DBCP, but would have unacceptable adverse impacts on the economic benefits of this use. Thus, in order to continue a registration of DBCP on plums, the terms of registration must be modified as described in Option 4.

M. Almonds

(1) Usage

Approximately 3,417,000 pounds of DBCP are applied to 70,600 acres of almond orchards annually, with a total of 181,200 acres, (54% of domestic almond acreage), subject to treatment. Almost all almonds are grown in California and all use of DBCP on almonds is in that state. Applications are done by post-plant irrigation every 18 to 36 months, depending on the severity of infestation. DBCP is generally applied in the San Joaquin Valley where the lighter soils support more nematode populations and where the trees are set on higher-yielding, but more nematode-susceptible peach-type rootstocks. No effective alternative method of postplant control is available.

(2) Risks

About 1,108 applicators are at risk. Inhalation exposure during application, and mixing and loading will result in increased cancer risk of 1.13 X 10^{-2} and 6.94 X 10^{-4}, respectively. There will also be risks of reduced sperm count for exposed males. Table 4 summarizes risks for other potential exposure situations.

(3) Benefits

If DBCP were unavailable, all treated orchards, 54% of total acres, would incur losses of $26,502,000 within 3 years. Consumers might experience up to a 20% increase in retail prices in the short term. Shippers and almond processors would be adversely affected to the extent that almond production would shift to other parts of California of the U.S. (Benefits Analysis).

In the long term, affected orchards would go out of production. Severely affected acres, 18% of the total planted, would begin to fail within 3 to 5 years and moderately-affected acres, 36% of total planted, would go out of production within 10 to 15 years. Almond producers in unaffected areas will have higher returns, which in turn would be expected to stimulate new plantings. Both factors would offset to some extent the losses suffered in current DBCP use areas. Production and retail prices may return to normal if new plantings are developed in uninfested areas.

(4) Regulatory Option and Their Impacts

Option 1: Continue registration without additional restrictions.

(i) Adverse Impacts - Risks to applicators would continue.

(ii) Beneficial Impacts - The nematode control advantages of DBCP would continue.

Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations; and require boots and gloves during application.

(i) Adverse Impacts - The risks from inhalation exposure to DBCP during application would continue . The costs of requiring protective equipment, including respirator, would total approximately $110 per person in the affected operations.

(ii) Beneficial Impacts - DBCP use by untrained persons would be eliminated. The risks from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. The risks to applicators from inhalation exposure during mixing and loading, spill clean-ups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 30 minutes per day, a practice with which most persons may be expected to comply. The nematode control advantages of DBCP would continue.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation.

(i) Adverse Impacts - There would still be some risks at one-fiftieth the level described in the almond and risk discussion, from inhalation exposure during irrigation. The costs of impostion these restrictions would be $110, the same as in Option 2.

(ii) Beneficial Impacts - These would be the same as in Option 2, but also the risks from inhalation exposure during irrigation would be reduced at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after irrigation would also be reduced. The nematode control advantages DBCP would continue.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques-- This Option is the same as Option 3, since all DBCP is applied by irrigation.

Option 5: Option 4 plus prohibit application by irrigation.

(i) Adverse Impacts - The 1,108 growers who had been using irrigation would be forced to switch to soil injection to maintain economic levels of production. If all growers applied DBCP themselves, the cost of application would increase $8 per acre, a total of $565,000 every 3 years or $515 per grower. If the DBCP were applied by commercial applicators, the costs would be $35 per acre, a total of $2,888,000 every 3 years or $2,606 per grower. The risk to applicators would be the same as in Option 4. The costs of protective equipment would be $110 per person. If all growers did not switch to injection, the total impact would be about $26,500,000. Although soil injection can cause some root damage, most growers would probably switch, since DBCP is necessary for economic production.

(ii) Beneficial Impacts - The high risks from inhalation and dermal exposures during and after irrigation would be completely eliminated, and the risks from inhalation during soil injection would be reduced at least fifty-fold. The risks from inhalation exposure during reentry into treated areas after soil injection would be reduced. The nematode control advantages of DBCP would continue.

Option 6: Cancel registrations

(i) Adverse Impacts - There would be significant adverse economic impacts as described in the almond benefit discussion.

(ii) Beneficial Impacts - All risks from DBCP use would be eliminated.

(5) Regulatory Chosen

Option 1 is rejected, because without further restrictions this use of DBCP will have unreasonable adverse effects on the environment. The Agency has selected Option 4 (which is the same as Option 3) since it will adequate by reduce risks without significant impacts on on the benefits of this use. Option 2 will not satisfactorily reduce risks and will result in unreasonable adverse effects. Options 5 and 6 will reduce or eliminate the risks of DBCP, but will have unacceptable adverse impacts on the economic benefits of this use. Thus, in order to continue a registration of DBCP on almonds, the terms of registration must be modified as described in Option 4.

N. Home Gardens

(1) Usage

The Cooperative Assessment (1977) estimated that 250,000 gardens, averaging one-fifth of an acre or less, are treated with DBCP. Most DBCP (80%) is incorporated into the soil as a granular formulation, while the remainder is applied in furrows as a liquid formulation and then covered with soil. Registered alternative chemicals include DD, EDB, Vapam and Vorlex. However, suitable equipment for applying DD and EDB is not generally available to home gardeners. Moreover, the cost of the alternatives is two to three times higher than DBCP and would produce equivalent or lower yield returns. Non-chemical methods of nematode control are either not practical or not effective. (Benefits Analysis).

(2) Risks

Assuming one person per treated garden applies the DBCP, about 250,000 persons are at risk during application. The risk to 200,000 people from inhalation exposure during use of the granular formulation is 6.57 X 10^{-5} probability of cancer. During in-furrow application, 50,000 people inhaling DBCP during application would have an increased cancer risk of 3.65 X 10^{-6}; during mixing and loading, inhalation of DBCP would lead to an increased cancer risk of 8.03 X 10^{-6}. All exposed males would risk reduced sperm counts. Table 4 summarizes risks from other potential exposure situation.

Assuming that eight persons per garden eat half of their diet from the 250,000 treated gardens, then these 2,000,000 people would be at risk from consuming DBCP residues. The lifetime risk per individual would be 3.19 X 10^{-4} ; about five cases of cancer could result in that population. There would also be a risk of reduced sperm count for males.

(3) Benefits

Most home gardens have esthetic rather than monetary value. Some home garden production decreases could occur, but the impacts would be minimal (Benefits Analysis).

(4) Regulatory Options and Their Impacts

Option 1: Continue registration without additional restrictions.

(i) Adverse Impacts - The risks to 2,000,000 persons consuming home garden vegetables containing DBCP residues would continue. The risks to gardeners who apply DBCP would continue.

(ii) Beneficial Impacts - The nematode control advantages of DBCP would continue.

Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations: and require boots and gloves during application.

(i) Adverse Impacts - The risks to 2,000,000 persons consuming home garden vegetables containing DBCP residues would continue . The risks from inhalation exposure to DBCP during application would continue. The costs of requiring protective equipment, including respirator, would be $110 per person in the affected operations.

(ii) Beneficial Impacts - DBCP use by untrained persons would be eliminated. The risk from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. The risks to applicators from inhalation exposure during mixing and loading, spill clean-ups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 30 minutes per year, a practice with which most persons may be expected to comply. The nematode control advantages of DBCP would continue.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation--
Not applicable.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques.

(i) Adverse Impacts - The risks to 2,000,000 persons consuming home garden vegetables containing DBCP residues would continue. There would still be some risks at one-fiftieth the level described in the home garden risk discussion, from inhalation exposure during application.

The cost of imposing these restrictions would be $110, as in Option 2, but it is unlikely that home gardeners would obtain certification and buy or use protective equipment.

(ii) Beneficial Impacts - These would be the same as in Option 2, but the risks to applicators from inhalation exposure during all applications would be decreased at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after soil injection would be reduced. The nematode control advantages of DBCP would continue.

Option 5: Option 4 plus prohibit application by irrigation--Not applicable.

(i) Adverse Impacts - There would be minimal adverse economic impacts, as described in the home garden risk discussion.

(ii) Beneficial Impacts - All risks from use of DBCP would be eliminated.

(5) Regulatory Option

Option 1 is rejected, because this use of DBCP will result in unreasonable adverse effects on the environment. The Agency has selected Option 6 for the 22 garden crops, since it will eliminate risks from DBCP, especially to the U.S. population from consumption of DBCP residues in food; at the same it will minimally adversely affect about 250,000 gardeners and result in some potential risks from use of substitute nematicides. Option 2 and 4 will not satisfactorily reduce risk and will result in unreasonable adverse effects. Thus, the Agency has determined that in order to prevent unreasonable adverse effects all registrations must be cancelled for these crops: broccoli, brussel sprouts, cabbage, carrots, cauliflower, celery, cucumbers, eggplant, endive, lettuce melons, lima bean, okra, parsnips, peppers, radishes, snap bean, southern pea and squash.

O. Home Lawns

(1) Usage

Since data was not available on the extent of DBCP use on home lawns, it was assumed, based on the data obtained for golf courses, that most applications on home lawns occur in Florida. There are 2,500,000 lawns, averaging one quarter acre, in that state (Florida Turfgrass Survey, 1974). If 5% of these were treated (Smart, 1978b), then there would be 125,000 users of DBCP or 31,250 acres. Approximately 80% of homeowners are estimated to use granular DBCP, while 20% use drench application (Table 11).

(2) Risks

For those persons using granular DBCP, the risk from inhalation exposure during application is 6.57×10^{-5} probability of cancer. For persons using drench, the risks from inhalation exposure during application is 1.28×10^{-3} probability of cancer. All exposed males risk decreased sperm counts. Table 4 summarizes risks from all other potential exposure situations,especially from potential dermal exposure.

(3) Benefits

According to the Cooperative Assessment, there are no practicable alternative nematicides for DBCP. Dasanit, Nemacur and Mocap are not allowed for use by homeowners. Diazinon (Sarolex) may be used, but it is not available through retailers at this time and is only effective against a few nematode species.

Without DBCP, affected turf would have to be totally replaced every 10 years (Smart, 1978b). The costs for a homeowner would vary according to the method of replacement. Completely covering a quarter-acre area with sod would cost about $1300, whereas using sprigs of sod and waiting a year for the lawn to fill in would cost $220. Assuming most persons would take the latter approach, the total cost to 125,000 homeowners over 10 years would be $27,500,000, or $2,750,000 per year.

(4) Regulatory Options and Their Impacts

Option 1: Continue registration without additional restrictions.

(i) Adverse Impacts - The risks to 125,000 applicators would continue.

(ii) Beneficial Impacts - The nematode control advantages of DBCP would continue.

Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations: and require boots and gloves during application.

(i) Adverse Impacts - The risks to 2,000,000 persons consuming home garden vegetables containing DBCP residues would continue . The risks from inhalation exposure to DBCP during application would continue. The costs of requiring protective equipment, including respirator, would be $110 per person in the affected operations.

(ii) Beneficial Impacts - DBCP use by untrained persons would be eliminated. The risk from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. The risks to applicators from inhalation exposure during mixing and loading, spill cleanups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 30 minutes per year, a practice with which most persons may be expected to comply. The nematode control advantages of DBCP would continue.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation-- Not applicable.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques.

(i) Adverse Impacts - The risks to 2,000,000 persons consuming home garden vegetables containing DBCP residues would continue. There would still be some risks at one-fiftieth the level described in the home garden risk discussion, from inhalation exposure during application. The cost of imposing these restrictions would be $110, as in Option 2, but it is unlikely that home gardeners would obtain certification and buy or use protective equipment.

(ii) Beneficial Impacts - These would be the same as in Option 2, but the risks to applicators from inhalation exposure during all applications would be decreased at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after soil injection would be reduced. The nematode control advantages of DBCP would continue.

Option 5: Option 4 plus prohibit application by irrigation--Not applicable.

Option 6: Cancel registrations.

(i) Adverse Impacts - There would be minimal adverse economic impacts, as described in the home garden risk discussion.

(ii) Beneficial Impacts - All risks from use of DBCP would be eliminated.

(5) Regulatory Option

Option 1 is rejected, because this use of DBCP will result in unreasonable adverse effects on the environment. The Agency has selected Option 4,(for commercial applicators only),since it will adequately reduce the risks from DBCP. Option 2 will not satisfactorily reduce risk and will result in unreasonable adverse effects. Option 6 would have unacceptable adverse economic impacts on homeowners in the Southeast. Thus, in order to continue a registration of DBCP on residential turf, the terms of registration must be modified as described in Option 4 (allowing use by certified commercial applicators only). In addition, drench application on residential turf will be prohibited, since such use would result in excessive exposure to persons living in or near a treated area.

P. Ornamentals

(1) Usage

Data are scarce on the extent of use of DBCP on ornamentals by either homeowners or nurseries. The Florida Department of Agriculture estimates that 4500 of the 8500 nurseries in that state use DBCP once every 2 years on annual and woody ornamentals (Stokes, 1978). The University of South Carolina Cooperative Extension Service estimates 1,800 acres of woody ornamentals are treated in that state (Miller, 1978b). At the University of Georgia Extension Service, 72% of many woody ornamental soil samples tested showed a nematode problem (Moody, 1978).In North Carolina, a recent Extension Service survey for nematode problems detected damaging levels of nematodes in 75% of the soil samples around boxwoods (Jones, 1978). There are 150 nurseries in that state. On the basis of this information, it was estimated that

that 5,000 persons might apply DBCP to ornamentals. Although injection, drench and granules are available application techniques, drench appears to be the method of choice. Dasanit and Mocap are registered substitutes, but are not as effective, must be applied more frequently, and cost more.

(2) Risks

When applying DBCP at rates similar to other use patterns, the risk to applicators from inhalations exposure during application is an 1.28×10^{-3} increased probability of cancer; during mixing and loading, the cancer risk would be increased by 8.03×10^{-6} . Exposed men would risk a reduced sperm count. Table 4 summarizes risks from other potential exposure situations.

(3) Benefits

From this usage data, it appears that DBCP is needed for treatment of nematode problems on ornamentals grown around homes or in nurserys. The Benefits Analysis did not estimate the cost impacts from the use of substitute materials. However, the Cooperative Assessment stated, "The total ornamental industry would not be greatly affected by loss of DBCP, but growers of some specialty ornamentals depend on it entirely. In those cases the growers would have production problems and suffer economic losses." Further, the Agency has compared the costs of controlling nematodes on boxwoods using DBCP, Mocap or Temik. The per acre costs over 8 years (average age of boxwoods when sold in nurseries) are, $100.68, $805.36 and $1,481.04 for the three chemicals, respectively (Roy 1978).

(4) Regulatory Options and Their Impacts

Option 1: Continue registration without additional restrictions.

(i) Adverse Impacts - The risk to 5,000 applicators would continue.

(ii) Beneficial Impacts - The nematode control advantages of DBCP would continue.

Option 2: Classify for restricted use; require fullbody protective clothing and respirator during transfer, maintenance or cleanup operations; and require boots and gloves during application.

(i) Adverse Impacts - The risks described from inhalation exposure to DBCP during application, in the ornamental risk discussion, would continue. The cost of requiring protective equipment, including respirator, would be $110 per person in the affected operations. Homeowners would not likely be willing to buy and use this equipment.

(ii) Beneficial Impacts - DBCP use by untrained persons would be eliminated. The risks from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. The risks to applicators from inhalation exposure during mixing and loading, spill cleanups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 30 minutes per day, a practice with which commercial applicators may be expected to comply. The nematode control advantages of DBCP would continue.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation--Not applicable.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques.

(i) Adverse Impacts - There would still be some risks, at one-fiftieth the level described in the ornamental benefit discussion. earlier from inhalation exposure during application. The cost of imposing these restrictions would be the same as in Option 2. Homeowners would not likely be willing to buy and use this protective equipment.

(ii) Beneficial Impacts - These would be the same as in Option 2, but the risks to applicators from inhalation exposure during all applications would be decreased at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after soil injection would be reduced. The nematode control advantages of DBCP would continue.

Option 5: Option 4 plus prohibit application by irrigation --Not applicable.

Option 6: Cancel registrations.

(i) Adverse Impacts - There would be minimal adverse economic impacts, as described in the ornamental benefit discussion. An unknown amount of Dasanit and Mocap would be used in place of DBCP. Since these pesticides are acutely toxic to humans, fish and wildlife, their use would pose some risks to man and the environment.

(ii) Beneficial Impacts - All risks from use of DBCP would be eliminated.

(5) Regulatory Option Chosen

Option 1 is rejected, because without further restrictions the use of DBCP will result in unreasonable adverse effects on th environment. The Agency has selected Option 4 for ornamentals (for commercial applicators only), since it will adequately reduce risk without significant impacts on the benefits of this use. Option 6 will eliminate the risks of DBCP, but will result in unacceptable adverse impacts on the economic benefits of this use and will create some potential risks from use of substitute nematicides. Thus, in order to continue a registration of DBCP on ornamentals, the terms of registration must be modified as described in Option 4 (allowing use by certified commercial applicators only). In addition, drench application of residential ornamentals will be prohibited, since such use would cause excessive exposure to persons living at or near a treated area.

Q. Apricots, Cherries, Figs and Walnuts

(1) Usage

Available data, including discussions with State Extension Service personnel, indicate that little if any DBCP is used for nematode control on these crops. There is minimal use of DBCP on these crops in California, where close to 100% of apricots, figs and walnuts are produced. Little or no DBCP is used on cherry orchards in Michigan, Oregon or Washington (Benefits Analysis). There are no registered substitute nematicides for postplant treatment of bearing trees.

(2) Risks

Because no DBCP is known to be applied to the above crops, no risks were calculated.

(3) Benefits

Since little or no DBCP has been identified on these crops, it must be concluded that any economic impact from the unavailability of DBCP would be insignificant However, if some nematode infestation were to occur in the future, DBCP would be the only registered for postplant use on bearing trees (Benefits Analysis).

(4) Regulatory Options and Their Impacts

(a) Option 1: Continue registrations without additional restrictions.

(i) Adverse Impacts -Risks to applicators could occur if DBCP were applied.

(ii) Beneficial Impacts - There are none.

Option 2: Classify for restricted use; require fullbody protective clothing and respirator during transfer, maintenance or cleanup operations; and require boots and gloves during application.

(i) Adverse Impacts - Any potential risks from inhalation exposure to DBCP during application would continue. The cost of requiring protective equipment, including respirator, would be $110 per person in the affected operations.

(ii) Beneficial Impacts - Potential DBCP use by untrained persons would be prevented. The risks from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. The risks to applicators from inhalation exposure during mixing and loading, spill cleanups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 30 minutes per day, a practice with which most persons may be expected to comply. The potential nematode control advantages of DBCP would continue.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation.

(i) Adverse Impacts - There would still be some risk, at one-fiftieth the unquantified level described in the plum risk discussion, from inhalation exposure during irrigation. The costs of imposing these restrictions would be $175, as in Option 2.

(ii) Beneficial Impacts - These would be the same as in Option 2, in addition to which the risks from inhalation exposure during irrigation would be reduced at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after irrigation would also be reduced. The nematode control advantages of DBCP would continue.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques--This Option is the same as Option 3, since most acres are treated by irrigation.

Option 5: Option 4 plus prohibit application by irrigation.

(i) Adverse Impacts - The growers who had been using irrigation would be likely to switch to soil injection, if necessary, in order to treat a nematode problem. If growers applied DBCP themselves, the cost of application would increase $8 per acre, and if they hired commercial applicators, the costs would be $35 per acre. The risks to applicators would be the same as in Option 4. The costs of protective equipment would be $175 per person.

(ii) Beneficial Impacts - The high risks from inhalation and dermal exposures during and after irrigation would be completely eliminated, and the risks from inhalation during soil injection would be reduced at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after soil injection would be reduced. The potential nematode control advantages of DBCP would continue.

Option 6: Cancel registrations.

(i) Adverse Impacts - There would be insignificant impacts at this time, since there is little or no use of DBCP. However, if any significant nematode infestations were to arise on these crops, the unavailability of DBCP would result in impacts similar to those found for other stone fruits (e.g., peaches and nectarines).

(ii) Beneficial Impacts - All risks from use of DBCP would eliminated.

(5) Regulatory Option

Option 1 is rejected, because without further restrictions on the potential use of DBCP will result in unreasonable adverse effects on the environment. The Agency has selected Option 4, since it will adequately reduce risk without significant impacts on the potential benefits of this use. Option 2 will not satisfactorily reduce risk and will result in unreasonable adverse effects for this use. Option 6 will eliminate the risks of DBCP, but will result in unacceptable adverse impacts on the potential economic benefits of this use. Thus, in order to continue a registration of DBCP on apricots, cherries, figs and walnuts, the terms and conditions of registration must be modified as described in Option 4.

R. Bananas

(1) Usage

No bananas are produced commercially for sale in the United States or its territories. Some bananas are grown for local consumption in Puerto Rico and Hawaii and these fruits are sometimes treated with DBCP (Holtorff 1978).

(2) Risks

Because little or no DBCP is known to be applied to bananas, no risks were calculated.

(3) Benefits

No measurable DBCP use has been identified for bananas in the United States and therefore no direct impacts would occur for growers in this country. However, it has been estimated by the Dow Chemical Company that if countries which export bananas to this country ban DBCP, the U.S. retail price could increase from 23.5 to 27.0 cents per pound. Based on the annual U.S. consumption of 4,200,000,000 pounds of bananas, the impact on consumers could total $150,000,000.

(4) Regulatory Options and Their Impacts

Option 1: Continue registrations without additional restrictions.

(i) Adverse Impacts - Risks to applicators could occur if DBCP were applied.

(ii) Beneficial Impacts - Benefits could occur if DBCP were applied. Any potential adverse effect on the price of imported bananas would be avoided.

Option 2: Classify for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations; and require boots and gloves during application.

(i) Adverse Impacts - Any potential risks from inhalation exposure to DBCP during application would continue. The cost of requiring protective equipment, including respirator, would be $110 per person in the affected operations.

(ii) Beneficial Impacts - Potential DBCP use by untrained persons would be prevented. The risks from dermal exposure to DBCP by all applicators would be virtually eliminated by the protective clothing. The risks to applicators from inhalation exposure during mixing and loading, spill cleanups, etc. would be reduced at least fiftyfold. Applicators would have to wear full protective clothing for only about 30 minutes per day, a practice with which most persons may be expected to comply. The potential adverse effect on the price of imported bananas would be avoided.

Option 3: Option 2 plus require a respirator and reentry interval for application by irrigation--Not applicable.

Option 4: Option 2 plus require a respirator and reentry interval for all application techniques.

(i) Adverse Impacts - There would still be some risk, at one-fiftieth the unquantified level described in the banana risk discussion, from inhalation exposure. The cost of these restrictions would be $110, as in Option

(ii) Beneficial Impacts - These would be the same as in Option 2, in addition to which the risks from inhalation exposure during irrigation would be reduced at least fiftyfold. The risks from inhalation exposure during reentry into treated areas after irrigation would also be reduced. The nematode control advantages of DBCP would continue and any potential adverse effect on the price of imported bananas would be avoided.

Option 5: Option 4 plus prohibit application by irrigation--Not applicable.

Option 6: Cancel registrations

(i) Adverse Impacts - There are no direct adverse impacts in the United States, since little or no DBCP is used in this country. However, if other banana growing countries were to ban DBCP, the price of imported bananas could increase from 23.5 to 27.0 cents per pound. Based on the U.S. consumption of 4.2 billion pounds of bananas, this price increase would result in a total impact of $150,000,000 to consumers.

(ii) Beneficial Impacts - Potential adverse human health effects would be prevented.

(5) Regulatory Option Chosen

Option 1 is rejected, because without further restrictions the potential use of DBCP on bananas would result in unreasonable adverse effects on the environment. The Agency has selected Option 4, since it would adequately reduce risks (if DBCP use were to occur) without significant impacts on the benefits of this use. Option 2 would not satisfactorily reduce risk if DBCP use were to occur and would have unreasonable adverse effects. Option 6 would eliminate the risks of DBCP, but could result in potentially unacceptable adverse impacts on the prices of imported bananas. In order to continue a registration of DBCP on bananas and to prevent adverse impacts on the price of bananas, the terms of registration must be modified as described in Option 4.

VI. Summary of Proposed Course of Action

In summary, the Agency has determined that if the following course of action is implemented, the continued use of DBCP would not result in unreasonable adverse effects on the environment:

Option 4: Classify DBCP for restricted use; require full-body protective clothing and respirator during transfer, maintenance or cleanup operations; require boots and gloves during application; and require a respirator and reentry interval for all application techniques: cotton, pineapples, soybeans, turf, strawberry nursery stock, ornamentals, bananas, commercial lima beans, commercial okra, commercial snap beans, commercial southern peas, citrus, grapes, peaches, nectarines, plums, almonds, apricots, cherries, figs, walnuts, blackberries, blueberries, boysenberries, dewberries, loganberries and raspberries.

Option 6: Cancel all registrations: broccoli, brussels sprouts, cabbage, carrots, cauliflower, celery, cucumbers, eggplants, endive, lettuce, lima beans (except commercial uses), melons, okra (except commercial uses), parsnips, peanuts, peppers, radishes, snap beans (except commercial uses), southern peas (except commercial uses), squash, tomatoes, turnips and strawberries (except strawberry nursery stock).

The impacts of and rationale for this course of action are summarized in Table 33.

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Original

Table 1. DBCP Sperm Count Data Adjusted to Include Azoospermic Men

Cohort	Exposed Workers					1/ Statistical Significance	Controls				
	Num-berr	Individuals		Percent			Num-ber	Individuals		Percent	
		<20 M/ml	<40 M/ml	<20 M/ml	<40 M/ml			<20 M/ml	<40 M/ml	<20 M/ml	<40 M/ml
Dow-Magnolia	117	63	68	45.3	58.1	p<.005	0	--	--	--	--
Dow-Midland	302	40	73	13.2	24.2	n.s.2/	70	9	22	12.9	31.4
Dow-Pittsburg	26	2	7	7.7	26.9	n.s.	0	--	--	--	--
Shell-Denver	56	11	23	19.6	41.1	n.s.	28	5	8	17.9	28.6
Shell-Mobile	87	15	35	17.2	40.2	n.s.	18	0	4	0	22.2
Chevron	5	1	2	20.0	40.0	(no test)	0	--	--	--	--
Velsicol	24	12	17	50.0	70.8	p<.005	0	--	--	--	--
Occidental	91	--	40	--	44.0	p<.005	35	--	4	--	11.4
Men from Infertile Marriages 3/.							9,000	1,630	2,619	18.1	29.1
Men from Fertile Marriages 4/							1,000			6	17

1/ The <20 and <40 sperm count groups of exposed individuals were tested (chi-square) against their own controls when data was available. Otherwise, exposed groups were tested against MacLeod's infertile marriage data.
2/ Not statistically significant.
3/ Unpublished. Permission for use granted by Dr. John MacLeod, New York Hospital, 1978.
4/ MacLeod, 1951.

Table 2. Estimated Cancer Risks to U.S. Population from Consuming Potential Food Residues of DBCP

Commercial Food Crops	Maximum Daily Intake of DBCP 1/ (ng/kg/day)	Lifetime Risk Per Individual 2/
Broccoli	0.87	1.05×10^{-5}
Brussel Sprout	<.0009	1.09×10^{-8}
Cabbage	0.0071	8.58×10^{-7}
Carrot	36.1	4.36×10^{-4}
Cauliflower	0.096	1.16×10^{-6}
Celery	0.038	4.59×10^{-7}
Cucumber	1.20	1.45×10^{-6}
Eggplant	0.0162	1.93×10^{-7}
Endive	<0.0009	1.09×10^{-8}
Lettuce	0.17	2.06×10^{-6}
Melon	5.60	6.77×10^{-5}
Parsnip	<0.005	6.05×10^{-8}
Peanut (meat)	2.7	3.26×10^{-5}
Pepper	<0.0013	1.57×10^{-8}
Radish	<0.0021	2.54×10^{-8}
Squash	0.25	3.02×10^{-6}
Strawberry	0.0019	2.30×10^{-8}
Tomato	5.80	7.01×10^{-5}
Turnip	<0.0086	1.04×10^{-7}
Totals:	52.83	6.39×10^{-4} 3/

1/ From Table 12.

2/ Source: Carcinogen Assessment Group, 1978. The one-hit model of risk assement was used.

3/ This figure is the equivalent of 2,008 cases of cancer per year. Carrots account for 68% of these cases, peanuts=57%, melons =5%, tomatoes=5% and all other crop together add up to 17%.

NOTE: These same crops grown in home gardens have been estimated to have a lifetime risk per individual of 3.19 X 10^{-4}. For the 2,000,000 persons potentially exposed, this risk might result in 5 cases of cancer per year. (CAG, 1978).

Table 3. Estimated Cancer Risks for Applicators Resulting From Inhalation of DBCP

Crop	State	1/ Application Method	2/ Persons Exposed	3/ Application Phase	Exposure per Person 4/ mg/hr	Exposure per Person 5/ hrs/yr	Exposure per Person 6/ g/40 yr	Cancer Risks Per Individual 7/	Cancer Risks Number of Cases
Citrus	TX	irr.	20	M&L	22	17	15	5.48×10^{-3}	.002
			20	Appl	18	333	239	8.72×10^{-2}	.025
	FL	inj.	10	M&L	.92	5	.18	6.57×10^{-5}	-
			22-28	Appl.	.18	100	.72	2.63×10^{-4}	-
	CA	irr.	263	M&L	22	.95	.84	3.07×10^{-4}	.001
			263	Appl.	18	19	14	5.11×10^{-3}	.020
		inj.	132	M&L	.92	0.25	.0091	3.32×10^{-6}	-
			132	Appl.	.18	5	.036	1.31×10^{-5}	-
	AZ	irr.	150	M&L	22	.95	.84	3.07×10^{-4}	.001
			150	Appl.	18	19	14	5.11×10^{-3}	.001
Cotton	South	inj.	1,271	M&L	.92	1.5	.055	2.01×10^{-5}	-
			1,271	Appl.	.18	29	.21	7.76×10^{-5}	.001
Grapes	CA	inj.	258	M&L	.92	.30	.011	4.02×10^{-6}	-
			258	Appl.	.18	6	.043	1.57×10^{-5}	-
		irr.	2,320	M&L	22	1.1	.97	3.54×10^{-4}	.012
			2,320	Appl.	18	21	15	5.48×10^{-3}	.181
Peaches and Nectarines	East	inj.	1,714	M&L	.92	0.25 8/	.0092	3.36×10^{-6}	-
			1,714	Appl.	.18	2	.014	5.11×10^{-6}	-
	CA	irr.	1,095	M&L	22	.65	.57	2.08×10^{-4}	.004
			1,095	Appl.	18	13	9.4	3.43×10^{-3}	.059

Peanuts	South	inj.	7,397	M&L	.92	.5	.083	6.57×10^{-6}	.001
			7,397	Appl.	.18	10	.072	2.63×10^{-5}	.003
Pineapple	HW	inj.	8	M&L	.22 9/	8.5 9/	.075	2.74×10^{-5}	-
			68	Appl.	.013	338	.18	6.57×10^{-5}	-
Soybeans	South	inj.	9,655	M&L	.92	1.4	.051	1.86×10^{-5}	.003
			9,655	Appl.	.18	27	.19	6.94×10^{-5}	.010
Commercial Vegetables	CA	inj.	200	M&L	.92	12	.44	1.61×10^{-4}	-
			200	Appl.	.18	233	1.7	6.21×10^{-4}	.002
	FL	inj.	709	M&L	.92	4.5	.17	6.21×10^{-5}	-
			709	Appl.	.18	90	.65	2.37×10^{-4}	.002
	Others	inj.	7,363	M&L	.92	1.4	.051	1.86×10^{-5}	.002
			7,363	Appl.	.18	27	.19	6.94×10^{-5}	.007
Turf (golf courses)	Fl, GA, SC & TX	comm.	11	M&L	.92	10	.37	1.35×10^{-4}	-
			11	Appl.	.18	200	1.4	5.11×10^{-4}	-
		own.	199	M&L	.92	1	.037	1.35×10^{-5}	-
			199	Appl.	.18	20	.14	5.11×10^{-5}	-
Strawberries (Nursery Stock)	MD	inj.	3	M&L	.92	2	.070	2.56×10^{-5}	-
			3	Appl.	.18	40	.29	1.06×10^{-4}	-
	DL	inj.	1	M&L	.92	5	.18	6.56×10^{-5}	-
			1	Appl.	.18	100	.72	2.63×10^{-4}	-
Other Berries	WA,OR	inj.	300	M&L	.92	0.25 7/	.0092	3.36×10^{-6}	-
			300	Appl.	.18	1	.0072	2.63×10^{-6}	-

Plums	CA	irr.	450	M&L	22	.65	.57	2.08×10^{-4}	.001
			450	Appl.	18	13	9.4	3.43×10^{-3}	.022
		inj. 10/	450	M&L	.92	.65	.023	8.40×10^{-6}	-
			450	Appl.	.18	13	.093	3.39 x 10-5	-
Almonds	CA	irr.	1,108	M&L	22	2.2	1.9	6.94×10^{-4}	.011
			1,108	Appl.	18	43	31	1.13×10^{-2}	.179
		inj.	1,108	M&L	.92	2.2	.081	2.96×10^{-5}	-
			1,108	Appl.	.18	43	.31	1.13×10^{-4}	.002
Home Gardens	South	gran.	200,000	Appl.	.44	10	.18	6.57×10^{-5}	.188
		furr.	50,000	M&L	1.1	0.5	.022	8.03×10^{-6}	.006
				Appl.	.025	10	.010	3.65×10^{-6}	.003
Home Lawns	FL	gran.	100,000	Appl.	.44	10	.18	6.57×10^{-5}	.023
		dren.	25,000	M&L	1.1	0.5	.022	8.03×10^{-6}	.003
			25,000	Appl.	8.8	10	3.5	1.28×10^{-3}	.456
Woody Ornamentals	FL, GA & SC	dren.	5,000	M&L	1.1	0.5	.022	8.03×10^{-6}	-
			5,000	Appl.	8.8	10	3.5	1.28×10^{-3}	.091
Totals			414,722						1.330

1/ Abbreviations are: irr. = irrigation, inj. = injection, comm. = injection by commercial applicator, own. = injection by owner, gran. = granular, dren. = drench, furr. = in-furrow.
2/ See Table 11.
3/ M&L = mixing and loading; Appl.= during application.
4/ Source: EPA Exposure Analysis, 1978.
5/ See Table 11. Figures are calculated by assuming that mixing and loading occur for 0.5 hr. for every 10 hrs. of application (Johnson, 1978; Key, 1978). For example, using the hr/yr/person for Texas citrus, there are 333 hours exposure during application. Therefore, the time involved in mixing and loading is (333 hr/10 hr day) X 0.5 hr = 17 hr.
6/ Figures in this column reflect the common practice of applying DBCP to perennials once every 3 years on all acres of a farm and once annually to all other crops.
7/ 95% upper confidence limit, using the one-hit model.
8/ The minimum time for a single mixing and loading operation is 15 minutes or 0.25 hr.
9/ 0.22 mg/hr is based on one 11 minute sample showing 4.5 ppb during transfer of DBCP from a supply truck to the application machine (Dollar and Hertlein, 1977). On the average a truck driver would be exposed (350 hr/yr/ 10 hr/day) X 0.25 hr M&L/day = 8.5/yr. Source of 0.25 hr M%L: Williams, 1978.
10/ While 100% of DBCP is applied by irrigation, these figures for exposuress during injection show the risks that may result from imposing a prohibiton on irigation application.

Table 4. Estimated Risks of Cancer Resulting From Potential Exposures to DBCP

Event	Route of Exposure	Estimated dose 1/	Probability of Cancer 2/
Spill Cleanup (85% DBCP)	Dermal	91 mg/drop	6.15 x 10^{-4}
	Inhalation	23 mg/hr	8.40 x 10^{-6}
Mixing and Loading (85% DBCP)	Dermal	91 mg/drop	6.15 X 10^{-4}
During application:			
Granular (5% DBCP)	Dermal	60 mg/hr	4.06 x 10^{-4}
Drench or In-furrow (0.02% DBCP)	Dermal	0.01 mg/drop	6.76 x 10^{-8}
Irrigation (0.0003% DBCP)	Dermal	0.0015 mg/drop	1.01 x 10^{-8}
Reentry after: 3/		(mg/hr)	
Injection	Inhalation		
1 day		0.07	2.56 x 10^{-8}
7 days		0.02	7.30 x 10^{-9}
Irrigation	Inhalation		
1 day		2.9	1.06 x 10^{-6}
7 days		N.A.4/	----------
In-furrow	Inhalation		
1 day		0.025	9.12 x 10^{-9}
7 days		0.020	7.30 x 10^{-9}
Drench	Inhalation		
1 day		0.001	3.65 x 10^{-10}
3 days		0.0003	1.10 x 10^{-10}
Granular	Inhalation		
1 day		N.A.	----------
7 days		N.A.	----------

1/ Assumes no protective equipment is worn by worker (Exposure Analysis).

2/ Risks are upper 95% confidence intervals using one-hit model andbased on EDB human data and relative potencies of DBCP to EDB (CAG,1978). Assumes one exposure in a lifetime.

3/ Assumes maximum label rates were applied.

4/ Not available.

Table 5. Potential Human and Environmental Hazards from Substitute Pesticides for DBCP[1]

Chemical	Hazards to Human				Environmental Hazards [3]	Regulatory Status
	Dermal[2]	Inhalation[2]	Sensitization	Chronic		
Ethylene dibromide	II	II, III, IV	Slight eye, skin and respiratory inflammation.	1) Oncogenicity 2) Teratogenicity 3) Mutagenicity	[4]	RPAR issued on basis of chronic effects.
Telone	II	III	Severe eye and skin irritation.	1) Mutagenicity 2) Liver, heart and kidney damage 3) No antidote	[4].	Being reviewed by SPRD as a candidate for RPAR, based on potential chronic hazards.
Vorlex	II	II	Eye and skin irritation.	[4]	[4]	The Registration Division has recommended vorlex for restricted use.
Nemacur	I, II	I	Some eye and skin irritation.	[4]	Toxic to terrestrial wildlife at relatively low concentrations	Domestic use may be classified restricted; non-domestic use will be general use (except two products that will be restricted).
Carbofuran	III	[4]	Minimal eye irritation.	1) Anticholinesterase effects 2) Reproductive effects 3) Immunological effects	Toxic to terrestrial wildlife at relatively low concentrations; if wildlife species are exposed, dieoffs can be expected.	Flowable will probably be restricted; granular will probably be general use; referred to SPRD based on reports of wildlife kills.
Dasanit	III	I	[4]	Anticholinesterase effects	Toxic to terrestrial wildlife. Significant wildlife losses can occur from its use on peanuts and soybeans	Referred to SPRD based on dermal LD-50 being less than 40 mg/kg. Otherwise, it will probably be classified for general use.
Mocap	I, II	IV	Some eye and skin irritation	Anticholinesterase effects	No assessment available, although incidents involving mocap and terrestrial wildlife have been reported to EPA.	Rejected from SPRD; recommended for restricted use.
D-D	II, III	III	Severe eye and skin irritation	1) Lung, liver and kidney damage 2) Mutagenicity	[4]	Being reviewed as a candidate for RPAR based on potential chronic hazards.

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[1] Does not take into account actual exposure situations. See table 9 for the amounts of substitutes that may replace DBCP for each use.

[2] Toxicity categories for dermal and inhalation LD-50's are listed in Federal Register, Vol. 40, No. 129, Part II, p. 28279, July 3, 1975.

[3] Adequate data were not available to perform a full risk assessment. However, some qualitative statements are made with respect to the acute toxicity of several of the substitute chemicals.

[4] No data available.

Table 6. DBCP SUSPENSION ORDER

FULLY SUSPENDED USES

- BROCCOLI
- BRUSSELL SPROUTS
- CABBAGE
- CARROTS
- CAULIFLOWER
- CELERY
- CUCUMBERS
- EGGPLANT
- ENDIVE
- LETTUCE
- MELONS
- PARSNIPS
- PEANUTS
- PEPPERS
- RADISHES
- SQUASH
- STRAWBERRIES
- TOMATOES
- TURNIPS

CONDITIONALLY SUSPENDED USES

- CITRUS
- COTTON
- GRAPES
- PEACHES
- NECTARINES
- PINEAPPLE
- SOYBEANS
- TURF
- STRAWBERRY NURSERY STOCK
- OTHER BERRIES
- PLUMS
- ALMONDS
- ORNAMENTALS

CONDITIONS:

RESTRICTED USE.
WEAR RESPIRATOR.
WEAR IMPERMEABLE PROTECTIVE CLOTHING.

Table 7. Costs of and Risk Reduction Offered by Protective Clothing and Respirators

Protective Device	Model	Resistant or Filtering Material	Other Specifications	Protection Factor 1/	Costs per Person: Per Item 2/	Costs per Person: Operation and Annual Maintenance
Gloves	Full length, heavy duty	Nitrile Neoprene	0.4 mm thick 0.4 mm thick	320,000 150,000	$ 10 $ 5	Replace when contaminated
Boot Covers	Disposable	"	"	"	$ 7	Replace when contaminated
Coat and Pants	Heavy duty raingear	"	"	"	$ 12	Replace when contaminated
Face Shield and Hard Hat	-----------	Plastic	-------	Unknown	$ 12	Replace when contaminated
Respirator	Canister or Cartridge	Treated charcoal	Half-face Full-face	10 50	N.A. $ 74	Canister = $12 per replacement.
	Supplied air and 50-foot hose	Pressure-demand or continuous flow	Half-face Full-face	1,000 2,000	$ 132 $ 224	Tank refill = $12 for 12 hrs. of air. 3/
	Self-contained breathing apparatus and one tank	Pressure-demand	Half-face Full-face	1,000 10,000	N.A. $ 626	Tank refill = $5 for 30 min. of air
		Demand	Half-face Full-face	10 50	N.A. $ 630	" "

1/ A protection factor is calculated by dividing the concentration of a chemical measured outside a device by the concentration that penetrates the device after a given time. The protection factor for the clothing materials are based on the penetration of 99% technical grade DBCP after 5 minutes (Sansone and Tewari, 1977). The protection factors listed for respirators are the minimum protection afforded by any brand of respirator (Hyatt, 1976).

2/ Quoted from Mining Safety Appliance Co. 1977 catalog.

3/ A canister must be thrown away after one day's exposure to DBCP (Kennedy, 1978)

Table 8. Economic Impacts of Cancelling DBCP[1]

Use	Grower		Consumer
	Control Cost Increase/yr.	Production loss/3 years	Retail Price Increases
CITRUS	0	$26,851,000	Up to 5%
COTTON	$2,600,000	Neglig.	Neglig.
GRAPES	0	$65,000,000	Major
PEACHES and NECTARINES	0	$80,672,000	Up to 25%
PINEAPPLE	$200,000	$5,793,000	Up to 9%
SOYBEAN	$23,471,000	Neglig.	Up to 0.25%
PEANUT	$3,515,000	$19,500,000	None
COMMERCIAL VEGETABLES	$7,728,000	$17,736,000	Up to 0.1%
HOME GARDENS	Neglig.	Neglig.	-----------
STRAWBERRY NURSERY STOCK	0	Cease production in East	Up to 18%
ALMONDS	0	$26,502,000	Up to 20%
APRICOTS, CHERRIES, FIGS AND WALNUTS	Neglig. due to no use	Neglig. due to no use	-----------
BANANAS	Neglig. due to no use	Neglig. due to no use	----------
OTHER VINE BERRIES	Neglig.	$ 500,000	Neglig.
PLUMS	0	$13,754,000	Up to 20%
HOME LAWNS	$2,750,000 to replace lawns	---------	Not applic.
COMMERCIAL TURF	$2,200,000 to $5,000,000	----------	Unknown
ORNAMENTALS	$100/A (treated acres unknown)	significant losses to small producers	Unknown
TOTALS:	$44,164,000	$268,253,000	---------

[1] Source: Benefits Analysis

Table 9. Substitute Pesticides Used if DBCP is Cancelled

Crop	Acres/Yr Treated w/DBCP 1/	Acres Treated/Yr w/Substitutes if DBCP Cancelled 1/	Rate of 1/ Application (lb/A)	Pounds/Yr of Substitute if. DBCP Cancelled 2/	3/ Total lbs. Substitute Used Before Cancellation	Percent Increase 4/
Citrus	31,200	0	——	0	0	0
Cotton	225,000	*DD = 108,000	85	9,200,000	7,015,000	130
		*EDB = 31,500	30	950,000	7,300,000	13
		*Telone=85,500	50	4,300,000	6,949,000	62
Grapes	82,500	0	——	0	0	0
Peaches & Nectarines	8,325 preplant	*DD = 2,775	500	1,400,000	7,015,000	20
		*EDB = 2,775	180	500,000	7,300,000	7
		*Telone= 2,775	400	1,100,000	6,949,000	16
	33,900 postplant	0	——	0	0	0
Peanuts	355,000	**DD = 12,968	100	1,300,000	7,015,000	18
		**EDB = 96,328	72	6,900,000	7,300,000	95
		**Telone = 18,525	60	1,100,000	6,949,000	16
		**Furadan = 16,080	3	48,000	5,000,000	1
		**Dasanit = 16,080	3	48,000	4,000,000	1.2
		**Mocap = 97,496	2	200,000	1,000,000	20
		**Nemacur = 97,496	2	200,000	N.A.5/	—
Pineapples	5,000	**EDB = 5,000	144	720,000	7,300,000	10
Soybeans	1,133,000	**DD = 516,000	120	62,000,000	7,015,000	884
		**Telone = 516,000	80	41,000,000	6,949,000	594
		*Mocap = 76,500	20	1,500,000	1,000,000	153
		*Nemacur = 17,000	20	340,000	N.A.	—
Commercial Vegetables	374,000	*DD = 115,447	110	13,000,000	7,015,000	181
		*EDB = 148,445	20	3,000,000	7,300,000	41
		*Telone = 62,880	80	5,000,000	6,949,000	72
		*Vorlex = 39,400	60	2,400,000	20,000	120
Commercial Turf (golf courses,etc)	18,500	**Mocap = 9,225 5/	25	230,000	1,000,000	23
		**Nemacur = 9,225 5/	14	130,000	N.A.	—
All berries, plums & almonds	80,500	None	——	0	0	0
Home Gardens		None	——	0	0	0
Home Lawns		None	——	0	0	0
Woody Ornamentals		**Dasanit = N.A.	44	N.A.	N.A.	—
		**Mocap = N.A.	18	N.A.	N.A.	—

1/ Source: USDA-EPA Benefit Analysis.

2/ Calculated by multiplying Acres treated/yr by the rate of application.

3/ Sources of production data are: DD, EDB, Telone and Furadan--EPA, 1975; Casanit, Mocap and Vorlex--NAS, 1974.

4/ Calculated by dividing lbs./yr of substitute if DBCP is cancelled by total pounds of substitute used on all crops before cancellation.

5/ Not available.

* Substitute pesticide is as efficacious as DBCP.

** Substitute pesticide is not as efficacious as DBCP.

Table 10. DBCP USE PATTERNS

Use	Pounds per Year	Acres Treated per year	Percent of Total Crop Treated	Application cycle
CITRUS	1,292,000	31,000	7.9	Once/3yrs
COTTON	2,700,000	225,000	2.0	Annually
GRAPES	3,200,000	83,000	31.0	Once/2 yrs.
PEACHES/ NECTARINES	1,823,000	42,000	44.0	Once/2-3 yrs.
PINEAPPLE	302,000	5,000	46.0	Once/3 yrs.
SOYBEAN	12,378,000	1,133,000	2.1	Annually
PEANUT	3,195,000	355,000	23.0	Annually
COMMERCIAL VEGETABLES	3,392,000	374,000	<0.1 to 95	Annually
HOME GARDENS	<200,000	NA	<0.5	Annually
STRAWBERRY NURSERY STOCK	16,000	600	10	Annually
ALMONDS	3,417,000	71,000	54.0	Once/3 yrs.
APRICOTS, CHERRIES, FIG AND WALNUTS	Neglig.	Neglig.	<0.1	________
BANANAS	Neglig.	Neglig.	<0.1	________
OTHER VINE BERRIES	92,000	600	<0.1 to 0.6	Once/3 yrs.
PLUMS	452,000	9,000	69.9	Once/3 yrs.
HOME LAWNS	<200,000	31,250	5.	Once/2 yrs.
COMMERCIAL TURF	550,000	18,500	Unknown	Once/2 yrs.
ORNAMENTALS	Unknown	Unknown	Unknown	Once/2 yrs.
TOTALS:	33,000,000	2,330,000	______	________

Source: Benefits Analysis and Cooperative Assessment

Notes to Table 11

a/ A small group of growers apply all DBCP used in Texas (Amadore, 1978).

b/ 10,000 acres/20 persons/1.5 acre/hr = 333 hrs.

c/ O'Bannon, 1978.

d/ 3,000 acres/10 persons/3 acres/hr = 100 hrs.

e/ Derived from Doane Survey, 1975, by dividing growers into acres grown by state.

f/ In California and Arizona, grapefruit = 7% and other citrus = 93% of acres grown in those states. Average farm sizes for those crops are 21 and 35 acres, respectively (Doane Survey, 1975). Thus, for California, (.07 X 13,200)/21 + (.93 X 13,200)/35 = 395 growers. For application by irrigation, .66 X 395 = 263; for injection, .33 X 395 = 132. The same method yields the number of growers in Arizona.

g/ Because of the broad range of farm sizes among different states, the number of farms treated was determined by summing the acres treated per state divided by the average farm size per state.

h/ Not available.

i/ Williams, 1978.

j/ Johnson, 1978b.

k/ 138,000 acres/200 persons/3 acres/hr = 233 hr.

L/ The USDA/EPA Cooperative Assessment estimates 375,000 acres of vegetables are treated in the U.S. Subtracting the acres treated in California (138,000), the 237,000 acres remaining may be divided between Florida and the Other states as follows. In 1974, Other States (excluding California) planted 375,000 acres, while Florida planted 214,000 A, for a sum of 589,000 acres. If Other States represent 65% of this sum and Florida represents 35%, then the treated acres in Other States are (.65 X 237,000) = 154,000 A, and the treated acres in Florida are (.35 X 237,000) = 83,000 A.

m/ Figures for custom application are derived as follows: Approximately 10 persons in Florida apply DBCP for an average of 200 hours per person per year (Russell, 1978). Only one custom applicator is located in Georgia (Lambert, 1978). Eleven persons working 200 hours per year at 3 A/hr. can cover 6,600 acres.

n/ Russell, 1978.

o/ Figures for application by golf course owners are derived as follows:
Acres treated: 900 (TX) + 3,500 (SC) + 7,500 (FL) = 11,900 acres.
Texas--15 courses x 60 A/course = 900 A (Walla, 1978) South Carolina--3,500 A treated (Miller, 1978a).
Florida--The USDA/EPA Cooperative Assessment estimates that 13,500 A were treated. Subtracting 6,000 A applied by custom applicators, 7,500 must be applied by owners.
Number of courses treated: Per above figures, 15 (TX) + 59 (SC) + 125 (FL) = 199 courses treated.

p/ (Puffinberger, 1978.

q/ Johnson, 1978a.

r/ derived from USDA/EPA Cooperative Assessment, 11/7/77.

s/ Based on EPA experimental data for drench and in-furrow applications of DBCP (Hansen *et al.*, 1977).

t/ Assumes 5% of 2,500,000 lawns in Florida are treated, with an average size of 0.25 A (Florida Turfgrass Survey, 1974).

u/ EPA estimate based on ROC's with knowledgeable persons in FL, SC and GA (Stokes, 1978; Miller, 1978; Moody, 1978). It is assumed that one ten-hour day per year per person is spent applying DBCP.

Table 11. DBCP Applicator Exposure: Number of Persons Exposed and Duration of Exposure

1/ Crop	State	Acres 2/ Treated Per Year	2/ Portions of Acres Treated By Application Method	3/ Avg. Farm Size, Acres	4/ Farms or Homes Treated By Application Method	5/ Acres Per Hour	Applicators	Helpers	Total Persons Exposed	6/ Hrs/ Year/ Person
Citrus	TX	10,000	100% irrigation	33	303	1.5	20 a/	0	20	333 b/
	FL	3,000	100% injection	96	31	3	10c/	12-18c/	22-28	100 d/
	CA	13,200	66% irrigation	21-35e/	263f/	1.5	263	0	263	14-23
			33% injection	21-35e/	132f/	3	132	0	132	4-6
	AZ	5,000	100% irrigation	21-36e/	160f/	1.5	150	0	150	14-23
Cotton	South	225,000	100% injection	177 e/	1,271	6	1,271	0	1,271	29
Grapes	CA	82,600	10% injection	32 e/	258	5	258	0	258	6
			90% irrigation	32 e/	2,320	1.5	2,320	0	2,320	21
Peaches and	East	12,000	100% injection	7	1,714	3	1,714	0	1,714	2
Nectarines	CA	21,900	100% irrigation	20	1,095	1.6	1,095	0	1,095	13
Peanuts	South	354,973	100% injection	29-84	7,397g/	6	7,397	0	7,397	5-14
Pineapple	HW	5,000	100% injection	NA h/	NA	0.6-3l/	8l/	68l/	74	246-430 l/
Soybeans	South	1,133,000	100% injection	41-292e/	9,655g/	6	9,655	0	9,655	7-48
Commercial	CA	138,000j/	100% injection	233	NA	3	200j/	0	200	233 k/
Vegetables	FL	83,000l/	100% injection	117	709	1.3	709	0	709	90
7/	Others	154,000l/	100% injection	10-63	7,363g/	1.3	7,363	0	7,363	7-47
Turf (golf -	FL, GA,	6,600m/	Custom injection	60 n/	110m/	3	11m/	11m/	22	200 m/
courses)	SC, & TX	11,900o/	Owner injection	60 n/	199o/	3	199o/	0	199	20
Strawberries	MD	300	100% injection	100 p/	3p/	2.5p/	3p/	0	3	40
(nursery stock)	DL	250	100% injection	250 p/	1p/	2.5p/	1p/	0	1	100
Other Berries8/	WA, OR	600	100% injection	2	300	2	300	0	300	1
Plums	CA	9,000	100% irrigationq/	20	450	1.5	450	0	450	13
Almonds	CA	71,000	100% irrigationq/	64	1,108	1.5	1,108	0	1,108	43
Home Gardens	South	50,000	80% granular r/	0.2r/	200,000	0.02s/	200,000	0	200,000	10
			20% in furrow r/	0.2r/	50,000	0.02s/	50,000	0	50,000	10
Home Lawns	FL	31,250t/	80% granularn/	0.25t/	100,000	0.02s/	100,000	0	100,000	10
			20% drench n/	0.25t/	25,000	0.02s/	25,000	0	25,000	10
Woody Ornamentals	FL, GA, SC	NA	100% drench	NA	5,000 u/	NA	5,000u/	0	5,000	10

1/ Apricots, cherries, figs, walnuts, bananas, blackberries, blueberries, dewberries and loganberries are omitted, since the amount of DBCP applied to these registered crops is negligible.

2/ Based on EPA-USDA Benefits Analysis, 1978, unless otherwise noted.

3/ From 1974 Census of Agriculture, Department of Commerce, unless otherwise noted.

4/ Calculated by dividing average farm size into acres treated by method of application.

5/ For soil injection, figures are calculated using the equation: Acres/hr = [Tractor speed (mph) X tool or row width (ft) X 5,280 ft/mile X 82.6% efficiency]/43,560 square feet per acre.

Crop	Tractor speed	Row width	Source
Florida citrus	2-3 mph	10-15 ft.	O'Bannon, 1978
Calif. citrus	3 mph	20 ft.	Johnson, 1978c
Cotton, soybeans	4.5 mph	13.3 ft.	Zygadlo, 1978
Golf fairways	5 mph	6 ft.	Broome, 1978
Calif. grapes	3-5 mph	12 ft.	Johnson, 1978b
Calif. vegetables	4 mph	6.6 ft.	Johnson, 1978d
Other vegetables	2 mph	6.7 ft.	Zygadlo, 1978
Eastern peaches	(estimated to be 2-4 A/hr)		Zehr, 1978

Irrigation for citrus, grapes, peaches and plums was estimated to be 1-2 A/hr based on average pipe diameter, field size and flow rates (Amadore, 1978; Johnson, 1978b).

6/ Calculated by dividing acres treated per hr. into avg. farm size, unless otherwise noted. One treatment per year is assumed.

7/ Includes annuals listed in Table 6, excluding cotton, peanuts and soybeans.

8/ Includes raspberries and boysenberries.

Table 12. Estimated Food Residues of DBCP in Commercial Crops

Food Crops	1/ Estimated Range of Residues (ppm)	2/ Grams of Food per Day	3/ Percent of Crop Treated w/ DBCP	4/ Daily Intake of DBCP (ng/kg/day)
Annuals:				
Broccoli	<0.01-0.15	1.5	27	.87
Brussel Sprout	<0.01-0.15	.45	<0.1 5/	<.0009
Cabbage	<0.01-0.15	11	0.3	.071
Carrot	<0.01-1.5	7.2	23.4	36
Cauliflower	<0.01-0.08	1.1	7.6	.096
Celery	<0.01-0.15	4.4	0.4	.038
Cottonseed	0	2.3	2.0	0
Cucumber	<0.01-0.05	11	15	1.2
Eggplant	<0.01-0.05	.45	5	.016
Endive	<0.01-0.15	.45	<0.1 5/	<.0009
Lettuce	<0.01-0.15	20	0.4	.17
Lima bean	0	2.9	20	0
Melon	<0.01-0.05	30	26	5.6
Okra	0	1.1	95	0
Parsnip	<0.01-0.80	.45	<0.1 5/	<.005
Peanut (meat)	<0.01-0.15	5.4	23	2.7
Pepper	<0.01-0.05	1.8	<0.1 5/	<.0013
Radish	<0.01-0.34	.45	<0.1 5/	<.0021
Snap bean	0	.45	10	0
Southern pea	0	10	75	0
Soybean	0	14	2.1	0
Squash	<0.01-0.05	.45	79	.25
Tomato	<0.01-0.05	43	19	5.8
Turnip	<0.01-0.80	.75	<0.1 5/	<.0086
Perennials:				
Almond	0	.45	54	0
Apricot	0	1.7	<0.1	0
Banana	0	21	0	0
Blackberry	0	.45	<0.1	0
Blueberry	0	.45	<0.1	0
Boysenberry	0	.45	<0.1	0
Cherries	0	1.5	<0.1	0
Citrus	0	57	7.9	0
Dewberry	0	.45	<0.1	0
Fig	0	.45	<0.1	0
Grape	0	7.4	31	0
Loganberry	0	.45	<0.1	0
Nectarine	0	.45	44	0
Peach	0	14	44	0
Pineapple	0	4.5	46	0
Plum	0	2.0	70	0
Raspberry	0	.45	<0.1	0
Strawberry	<0.01-0.05	2.7	<0.1	<.0019
Strawberry 6/	0	---	100	0
Walnut	0	.45	<0.1	0
			Total:	52.83

1/ Cummings, 1978.
2/ Source: Schmitt, 1977.
3/ Source: USDA/EPA Economic Assessment.
4/ These figures take into account the percent of each crop treated in 1976. They also assume that the average person weighs 70 kg and that the maximum residue figure in column 1 will be consumed. For example, for broccoli, [(0.15 ppm X 1.5 g)/70 kg/day] X 27% = .87 ng/kg/day.
5/ Negligible or no use of DBCP reported (Toria, 1978). In order to calculate the hypothetical daily intake of DBCP for these crops, however, it is assumed that 0.1% of the planted acres of the crop are treated.
6/ Eastern nursery stock.

Table 13. Toxicological Test Results for DBCP

Test	Dose Levels and Duration	Species	Sex and number	Results	Source
Acute oral LD-50	DNS*	Rat	M	170-300 mg/kg	Torkelson 1961
	DNS	Rat	M/F	350 mg/kg	Rakhmatullayev 1969
	DNS	Rat	F	260-410 mg/kg	Torkelson 1961
	DNS	Rat	M/F	380 mg/kg	Rakhmatullayev 1969
	DNS	Rabbit	M/F	180 mg/kg	Torkelson 1961
	DNS	Guinea Pig	M	210 mg/kg	Torkelson 1961
	DNS	Guinea Pig	M/F	316 mg/kg	Rakhmatullayev 1969
	DNS	Chicken	unsorted	60 mg/kg	Torkelson 1961
	DNS	Mallard duckling	M/F	66.8 mg/kg	Tucker and Crabtree 1970
Skin Irritation	0.5 ml undiluted DBCP, 20 applications	Rabbit	4 animals	No erythema on intact skin; slight erythema on abraded skin; microscopic effects more severe.	Torkelson 1961
Eye Irritation	1.0% DBCP in propylene glycol	Rabbit Rabbit	not given	Slight irritation of the conjunctiva and iris.	Torkelson 1961
Acute dermal	Undiluted DBCP, for 24 hr	Rabbit	not given	LD-50 = 1400 mg/kg	Torkelson 1961

* DNS = doses not specified

Table 13. (Continued)

Test	Dose Levels and Duration	Species	Sex and number	Results	Source
Subacute dermal	0.25 g DBCP, 10 24 hr applications	Rabbit	not given	Slight hyperemia and scaliness	Torkelson 1961
Acute inhalation	DNS	Rats	M	Eye and respiratory irritation seen at 60 ppm; kidneys permanently scarred at 50 ppm.	Torkelson 1961
	8 hr exposure			LC-50 = 103 ppm	
	4 hr exposure			LC-50 = 154 ppm	
	2 hr exposure			LC-50 = 232 ppm	
	1 hr exposure			LC-50 = 368 ppm	
Repeated inhalation	0, 5, 10, 20 and 40 ppm; 50 exposures over 7 wk	Rats	15 M per dose group	Gross lesions in lungs, intestinal mucosa, kidneys and testes at 10, 20 and 40 ppm. Testes atrophied at 20 and 40 ppm. testicular weight reduced in some males at 5 ppm.	Torkelson 1961
	0 and 12 ppm; 66 exposures over 70-92 days	Rats	20 M, 20 F	Lung weights significantly greater than controls at 12 ppm; marked pathological changes occurred in testicles	Torkelson 1961
	0 and 12 ppm; 66 exposures over 70-92 days	Rabbits	3M, 3F	Severe atrophy and degeneration of testes at 12 ppm	Torkelson 1961

Table 13. (Cont'd)

Test	Dose Levels and Duration	Species	Sex and number	Results	Source
	12 ppm; 66 exposures over 70-92 days	G. Pig	10M + 10F	Severe atrophy and degeneration of testes at 12 ppm.	Torkelson 1961
	12 ppm; 50 and 60 exposures over 70-92 days	Monkey	2F	Developed severe secondary infections; aplastic anemia evident	Torkelson 1961
Intramuscular injec.	25 mg/kg for 3 days, repeated	Rat	5M + 5F	No significant hematologic changes	Torkelson 1961
Sub-chronic Ingestion	0, 5, 20, 50, 150 450 and 1350 ppm in diet for 90 days	Rat	14M + 14F per dose	Weight gain retarded at 150 ppm for F, and at >450 ppm for M and F. Minimal cloudy swelling in 5 male livers and in several F kidneys.	Torkelson 1961
	70, 35 and 17.5 mg/kg perorally for 10 weeks	Rat	10M/dose	High dose produced necrotic changes in the parenchymatous organs and testes; other doses disturbed blood cell counts, liver function and nucleic acids.	Rakhmatullayev 1970
	0, 0.005, 0.05, 0.5 and 5.0 ppm for 8 months	Rat	7M/dose	Adverse effects on testes at 5 mg/kg, diminished fertility at 0.5 mg/kg and no testicular effect at .05 mg/kg. Kidneys, liver, reflexes and blood disturbed at dose as low as 0.05 mg/kg.	Rakhmatullayev 1970

Table 13. (Cont'd)

Test	Dose Levels and Duration	Species	Sex and number	Results	Source
Acute aquatic	100 ppm; 72 hr.	Redeared sunfish	20 fish per dose	No toxic effect	McCann, 1970
	32-180 ppm; 24 hr 48 hr 96 hr	Rainbow trout	-	LC-50 = 115.00 ppm LC-50 = 85.00 ppm LC-50 = 36.50 ppm	McCann, 1977
	0.25, 0.50, 1, 2.5, 5 and 10 ppm;	Clam	-	Larvae survival was 14% at 1 ppm and <1% at 2.5 ppm	Davis and Hidu 1969
	DNS; 24 hr 48 hr	Bass	20 fish per dose	TLm = 30-50 ppm TLm = 20 ppm	Davis and Hard-castle 1959
	DNS; 24 hr 48 hr	Bluegill	20 fish per dose	TLm = 50-125 ppm TLm = 20 ppm	Davis and Hard-Castle 1959
	DNS; 48 hr at 22 °C.	I. exustus S. libertina C. malleata P. acuta (all freshwater snails)	-	TLm = 57 ppm TLm = 50 ppm TLm = 53 ppm TLm = 24 ppm	Nishiuchi and Yoshida 1972
	10, 20, 30, 40, 60, 80 and 100 ppm; 72 hr	Lake emerald shiners	5 fish per dose	Toxic effects at 20 ppm; LC-100 = 60 ppm.	Alexander 1973
	0, 6.5, 7.5, 10.0, 12.0 and 14.0 ppm for 24, 48 and 96 hr	Pink Shrimp	5 shrimp per dose	96 hr LC-50 = 12.7 ppm	Heitmuller 1974

Table 13. (Cont'd)

Test	Dose Levels and Duration	Species	Strain	Results	Source
Mutagenicity	———	E. coli	pol A_1-, pol A_1+	DBCP blocked growth of E.coli pol A_1-, which indicates effect on cellular DNA.	Rosenkranz, 1975
	———	Salmonella typhimureum	TA1530, TA1538	DBCP was mutagenic for TA1530 and not TA1538, which indicates it induced base-substitution mutations, but not frameshift mutations.	Rosenkranz, 1975
	———	Salmonella typhimureum	TA100, TA1535, TA1538	DBCP was mutagenic for TA1535, which indicates it induced base-pair substitution mutations.	Prival, 1977

Table 14. DBCP Use Patterns

Use	Pounds per Year	Acres Treated/Yr.	Percent of Crop Treated	Application Cycle
CITRUS	1,292,000	31,000	7.9	Once/3 yrs.
COTTON	2,700,000	225,000	2.0	Annually
GRAPES	3,200,000	83,000	31.0	Once/3 yrs.
PEACHES/NECTARINES	1,823,000	42,000	44.0	Once/3 yrs.
PINEAPPLE	302,000	5,000	46.0	Once/2-3 yrs.
SOYBEAN	12,378,000	1,133,000	2.1	Annually
PEANUT	3,195,000	374,000	23.0	Annually
COMMERCIAL VEGETABLES, MELONS AND STRAWBERRIES	3,392,000	71,000	<0.1-95	Annually
HOME GARDENS	<200,000	Not avail.	Not avail.	Annually
STRAWBERRY NURSERY STOCK	16,000	600	10	Annually
ALMONDS	3,417,000	71,000	54.0	Once/3 yrs.
APRICOTS, CHERRIES, FIG AND WALNUTS	Neglig.	Neglig.	<0.1	———
BANANAS	Neglig.	Neglig.	<0.1	———
OTHER VINE BERRIES	92,000	600	<0.1 to 0.6	Once/3 yrs.
PLUMS	452,000	9,000	69.9	Once/3 yrs.
HOME LAWNS	<200,000	31,250	5.	Once/2 yrs.
COMMERCIAL TURF	550,000	18,500	Unknown	Once/2 yrs.
ORNAMENTALS	Unknown	Unknown	Unknown	Once/2 yrs.
TOTALS:	33,000,000	2,330,000	———	———

Source: Benefits Analysis and Cooperative Assessment

TABLE 15. IMPACTS OF REGULATORY OPTIONS FOR DBCP FOR CITRUS IN CALIFORNIA, TEXAS, FLORIDA AND ARIZONA.

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (593 applicators)	For cancer risk, see Tables 3 and 4 for specific risk estimates. There is also a risk of decreased sperm count; this risk cannot be quantified.	None	None	Nematode control continues	Current prices continue	Unreasonable risks continue for applicators.
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During Application.	For mixing and loading, dermal risks are reduced nearly 100% and inhalation risk is reduced by factor of 50 (i.e., 98%). Risk during application continues.		None	None	$175 per person for protective equipment.	"	Grower compliance is likely.
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.	Additionally, risk during irrigation application and from reentry after irrigation are reduced by factors of at least 50 and 6, respectively.		None	None	"	"	"
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during all other application methods and from reentry after these methods are reduced by factors of at least 50 and 13, respectively		None	None	"	"	"
5. #4 plus: Prohibit Application by Irrigation	Additionally, risks from irrigation are eliminated, but growers switching to injection would be exposed to the same risks as in #4.		None	None	Impacts on growers uncertain. If all growers using irrigation switched to injection, their application costs would total $190,000-$830,000 per 3 yrs. on 23,700 acres, or $265-$1160 per grower. Most growers would probably stop using DBCP, since injection damages roots and disrupts no-till weed programs. If all growers stopped using DBCP, the impact would be the equivalent of cancellation for them (=$21 M).		
6. Cancel Registrations	All DBCP risks are eliminated.		No substitutes available.		$27,000,000 per 3 yr. cycle. Grove life is shortened from 60 to 30-40 yrs.	Up to 5% price increase	With no post-plant nematicide, the short and long term impacts of cancelling DBCP are severe.

TABLE 16. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON COTTON.

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (1,271 applicators)	For cancer risk, see Tables 3 and 4 for specific risk estimates. There is also a risk of decreased sperm count; this risk cannot be quantified.	None	None	Nematode control continues	Current prices continue	Unreasonable risks continue for applicators,
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During application.	For mixing and loading, dermal risk is reduced nearly 100% and inhalation risks reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment,	" [illegible]	Grower compliance is likely,
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.	Additionally, risk during irrigation application and from reentry after irrigation are reduced by factors of at least 50 and 6, respectively.		None	None	"	"	" "
4. #2 plus: Respirator and Reentry Interval for All Application Methods,	Additionally, risks during application and from reentry after application are reduced by factors of at least 50 and 13, respectively.		None	None	"	"	" "
5. #4 plus: Prohibit Application by Irrigation	Additionally, potential risks from irrigation are eliminated, but growers applying by injection would be exposed to the same risks as in #4.		None	None	"	"	" "
6. Cancel Registrations	All DBCP risks are eliminated.		No environmental risks are known, but some chronic hazards from DD, EDB and Telone exist (see Table 5). The pounds of these that would be applied are, respectively, 9,200,000 950,000 and 4,300,000 , which represent 130%, 13% and 62% of trhe amounts of these chemicals produced in 1974 or 1975.		$2,600,000 per year to use substitutes. This cost is <0.1% of the value However, the average costs to each of 1,271 affected growers would be $2,000 per year.	Negligible	The risks of DBCP would be replaced with risks from the substitute chemicals.

TABLE 17. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON GRAPES IN CALIFORNIA.

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (2,578 applicators)	For cancer risk, see Tables 3 and 4 for specific risk estimates. There is also a risk of decreased sperm count: this risk cannot be quantified.	None	None	Nematode control continues	Current prices continue	Unreasonable risks continue for applicators.
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During Application.	For mixing and loading, dermal risks are reduced nearly 100%, and inhalation risks reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment,	"	Grower compliance is likely.
3. #2 plus: Respirator and Reentry Interval for Irrigation Application,	Additionally, risks during irrigation application and from reentry after irrigation are reduced by factors of at least 50 and 6, respectively.		None	None	"	"	"
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during all other application methods and from reentry after these methods are reduced by factors of at least 50 and 13, respectively.		None	None	"	"	"
5. #4 plus: Prohibit Application by Irrigation	Additionally, risks from irrigation are eliminated, but growers switching to injection would be exposed to the same risks as in #4.		None	None	Impacts on growers uncertain. If all 2,320 growers who irrigate switched to injection, their application costs would total $594,000-$2,600,000 per 3 yrs. on 74,300 acres, or $256-$1120 per grower per 3 yr. cycle. Although soil injection can cause some root damage, most growers would probably use it, since DBCP is necessary for economic production. However, if all growers who irrigate stopped using DBCP, the impact would be the equivalent of cancellation for them (=$58.5 M).		
6. Cancel Registrations	All DBCP risks are eliminated.		No substitutes available.		$65,000,000 per 3 yr. cycle. Vineyard life is shortened from 30-60 to 10-15 yrs.	Up to 5% price increase	With no post-plant nematicide, the short and long term impacts of cancelling DBCP are severe.

TABLE 18. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON PEACHES AND NECTARINES IN CALIFORNIA AND EASTERN UNITED STATES.

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (1,714 applicators)	For cancer risk, see Tables 3 and 4 for specific risk estimates. There is also a risk of decreased sperm count; this risk cannot be quantified.	None	None	Nematode control continues	Current prices continue	Unreasonable risks continue for applicators.
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During Application.	For mixing and loading, dermal risks are reduced nearly 100%, and inhalation risks reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment.	"	Grower compliance is likely.
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.	Additionally, risks during irrigation application and from reentry after irrigation are reduced by factors of at least 50 and 6, respectively.		None	None	"	"	" "
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during all other application methods and from reentry after these methods are reduced by factors of at least 50 and 13, respectively.		None	None	"	"	" "
5. #4 plus: Prohibit Application by Irrigation	Additionally, risks from irrigation are eliminated, but growers switching to injection would be exposed to the same risks as in #4.		None	None	Impacts on growers uncertain. If all 1,095 growers who irrigate switched to injection, their application costs would total $175,000-$767,000 per 3 yrs. on 21,900 acres, or $160-700 per grower per 3 yr. cycle. Although soil injection can cause some root damage, most growers would probably use it, since DBCP is necessary for economic production. However, if all growers who irrigate stopped using DBCP, the impact would be the equivalent of cancellation for them (=$52 M).		
6. Cancel Registrations	All DBCP risks are eliminated.		No substitutes available,		$80,672,000 per 3 yr. cycle. Grove life is shortened from 12-13 to 6-7 yrs,	Up to 25% price increases.	With no post-plant nematicide, the short and long term impacts of cancelling DBCP are severe.

TABLE 19. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON PEANUTS IN TEXAS, OKLAHOMA AND THE SOUTHEASTERN UNITED STATES*,

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (593 applicators) and ingestion by U.S population.	For cancer risk, see tables 2,3 & 4 for specific risk estimates. There is also a risk of decreased sperm count; this risk cannot be quantified.	None	None	Nematode control continues	Current prices continue	Unreasonable risks continue for applicators and the general population,
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During Application.	For mixing and loading, dermal risk are reduced nearly 100% and inhalation risks are reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment.	"	Grower compliance is likely.
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.			NOT APPLICABLE				
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during application and from reentry after application are reduced by factors of at least 50 and 13, respectively.		None	None	"	"	"
5. #4 plus: Prohibit Application by Irrigation			NOT APPLICABLE				
6. Cancel Registrations	All risks are eliminated.		Wildlife losses can occur from use of furadan, dasanit, mocap and nemacur. Chronic hazards for humans exist from DD, EDB and Telone (Table 5). Some of the substitutes would be applied in large amounts (see Table 9).		$6,800,000/yr Greatest impacts would occur in Oklahoma and Texas, where it would no longer be profitable for 10% of the growers to grow peanuts.	None	Risks of DBCP may be replaced by significant human and environmental hazards. In the long term, about 648 farmers may be forced to grow other crops.

*/ This crop has been unconditionally suspended in the Administrator's Suspension Order of October 27,1977.

TABLE 20. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON PINEAPPLES IN HAWAII

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (76 applicators)	For cancer risk, see Tables 3 and 4 for specific risk estimates. There is also a risk of decreased sperm count; this risk cannot be quantified.	None	None	Nematode control continues	Current prices continue	Unreasonable risks continue for applicators.
2. Restricted Use: Clothing and Respirator during Mix and Load; Boots and Gloves During application.	For mixing and loading, dermal risk is reduced nearly 100% and inhalation risks reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment.	"	Grower compliance is likely.
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.			NOT APPLICABLE				
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during application and from reentry after application are reduced by factors of at least 50 and 13, respectively.		None	None	"	"	" "
5. #4 plus: Prohibit Application by Irrigation			NOT APPLICABLE				
6. Cancel Registrations	All DBCP risks are eliminated.		There are no known environmental risks, but several chronic hazards are associated with the only substitute, EDB (see Table 5). 720,000 pounds would be applied; this quantity is 10% of the amount produced in 1976.		$6,200,000 per year beginning on the third year.	Up to 9% price increase	The risks of DBCP would be replaced with risks from EDB.

TABLE 21. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON SOYBEANS IN THE SOUTHEASTERN UNITED STATES.

	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		
REGULATORY ALTERNATIVES	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	DISCUSSION OF ISSUES AND TRADE-OFFS
1. Continued Registration	Inhalation and dermal (9,655 applicators)	For cancer risk, see Tables 3 and 4 for specific risk estimates. There is also a risk of decreased sperm count; this risk cannot be quantified.	None	None	Nematode control continues	Current prices continue	Unreasonable risks continue for applicators.
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During application.	For mixing and loading, dermal risk is reduced nearly 100% and inhalation risks reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment.	"	Grower compliance is likely,
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.			NOT APPLICABLE				
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during application and from reentry after application are reduced by factors of at least 50 and 13, respectively.		None	None	"	"	"
5. #4 plus: Prohibit Application by Irrigation			NOT APPLICABLE				
6. Cancel Registrations	All risks are eliminated.		Wildlife losses can occur from use of nemacur (see Table 5). There are chronic hazards for humans from DD, EDB and Telone (Table 5). Unusually large amounts of each substitute would be applied (see Table 9).		$23,500,000/yr This is <0.1% of the total value of soybeans. However, about 6600 growers in the Delta region would lose 44% of profits and 3,000 growers in the Southeast would lose 36% of profits.	Neglig.	Risks of DBCP may be replaced by significant human and environmental hazards, and some growers might be forced to grow other crops.

TABLE 22. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON COMMERCIAL VEGETABLES, MELONS AND STRAWBERRIES NATIONWIDE*

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (8,272 applicators) and ingestion by U.S population.	For cancer risk, see tables 2,3 & 4 for specific risk estimates. There is also a risk of decreased sperm count; this risk cannot be quantified.	None	None	Nematode control continues	Current prices continue	Unreasonable risks continue for applicators and the general population.
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During Application.	For mixing and loading, dermal risk are reduced nearly 100% and inhalation risks are reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment.	"	Grower compliance is likely.
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.			NOT APPLICABLE				
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during application and from reentry after application are reduced by factors of at least 60 and 13, respectively.		None	None	"	"	" "
5. #4 plus: Prohibit Application by Irrigation			NOT APPLICABLE				
6. Cancel Registrations	All risks are eliminated.		There are chronic hazards for humans from DD, EDB and Telone and Vorlex (see Table 6). The pounds of these that would be applied are, respectively, 13,000,000; 3,000,000; 5,000,000; and 2,400,000, which represent 181%, 41%, 72% and 120% of the amounts of these chemicals produced in 1974 or 1975.		$14,600,000/yr Greatest impacts would occur in tomatoes and watermelons. 8,100 growers are affected.	None	Risks of DBCP may be replaced by significant human and environmental hazards.

*/ 19 of 23 of these crops have been unconditionally suspended by the Administrator's Suspension Order of October 27, 1977. The four crops in which no DBCP residues are expected are lima beans, okra, snap beans and southern peas.

TABLE 23. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON COMMERCIAL TURF (GOLF COURSES IN FLORIDA, TEXAS, SOUTH CAROLINA AND GEORGIA)

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (309 applicators)	For cancer risk, see Tables 3 and 4 for specific risk estimates. There is also a risk of decreased sperm count; this risk cannot be quantified.	None	None	Nematode control continues	Current prices continue	Unreasonable risks continue for applicators.
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During application.	For mixing and loading, dermal risk is reduced nearly 100% and inhalation risks reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment,	"	Grower compliance is likely,
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.			NOT APPLICABLE				
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during application and from reentry after application are reduced by factors of at least 50 and 13, respectively.		None	None	"	"	" "
5. #4 plus: Prohibit Application by Irrigation			NOT APPLICABLE				
6. Cancel Registrations	All risks are eliminated.		Wildlife losses can occur from use of nemacur and mocap (see Table 6). The pounds of these applied are 130,000 and 230,000 pounds, respectively.		$2,200,000 to $5,600,000 per year from the higher cost of the substitutes. For 310 golf courses, the costs would be $7,100-$18,100/yr.	None	Risks of DBCP may be replaced by some wildlife hazard.

TABLE 24. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON STRAWBERRY NURSERY STOCK IN DELAWARE AND MARYLAND

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (4 applicators)	For cancer risk, see Tables 3 and 4 for specific risk estimates. There is also a risk of decreased sperm count; this risk cannot be quantified.	None	None	Nematode control continues	Current prices continue	Unreasonable risks continue for applicators.
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During application.	For mixing and loading, dermal risk is reduced nearly 100% and inhalation risks reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment,	"	Grower compliance is likely.
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.			NOT APPLICABLE				
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during application and from reentry after application are reduced by factors of at least 50 and 13, respectively.		None	None	"	"	"
5. #4 plus: Prohibit Application by Irrigation			NOT APPLICABLE				
6. Cancel Registrations	All DBCP risks are eliminated.		No substitutes available.		$1,500,000 to $5,600,000 per year.	Up to 18% price increase in the East.	Some growers could possibly be forced out of production.

TABLE 25. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON OTHER BERRIES* IN WASHINGTON, OREGON AND CALIFORNIA

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (only applicators)	There is a potential risk of cancer if DBCP is applied. There is also a potential risk of decreased sperm count; this risk cannot be quantified.	None	None	Since there is little or no use of DBCP on these berries, no one realizes an economic benefit from DBCP.		Unreasonable risks could occur for applicators if DBCP were used.
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During application.	For mixing and loading, dermal risk is reduced nearly 100% and inhalation risks reduced by factor of 50 (i.e., 98%). Risks during application would continue if DBCP were used.		None	None	$175 per person for protective equipment.	"	Grower compliance would be likely,
3. #2 plus: Respirator and Reentry Interval for Irrigation Application,	Additionally, risk during irrigation application and from reentry after irrigation would be reduced by factors of at least 50 and 6, respectively.		None	None	"	"	"
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during application and from reentry after application would be reduced by factors of at least 50 and 13, respectively.		None	None	"	"	"
5. #4 plus: Prohibit Application by Irrigation	Additionally, potential risks from irrigation are eliminated, but growers applying by injection would be exposed to the same risks as in #4.		None	None	"	"	"
6. Cancel Registrations	All potential DBCP risks would be eliminated.		No substitutes available.		$1,000,000 in production losses for boysenberries and raspberries.	No effect on consumer prices,	Cancellation would prevent DBCP use in the future if nematodes are problem.

*/ blackberries, blueberries, dewberries, loganberries, raspberries.

TABLE 26. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON PLUMS IN CALIFORNIA.

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (450 applicators)	For cancer risk, see Tables 3 and 4 for specific risk estimates. There is also a risk of decreased sperm count: this risk cannot be quantified.	None	None	Nematode control continues	Current prices continue	Unreasonable risks continue for applicators.
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During Application.	For mixing and loading, dermal risks are reduced nearly 100%, and inhalation risks reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment,	"	Grower compliance is likely.
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.	Additionally, risks during irrigation application and from reentry after irrigation are reduced by factors of at least 50 and 6, respectively.		None	None	"	"	"
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during all other application methods and from reentry after these methods are reduced by factors of at least 50 and 13, respectively.		None	None	"	"	"
5. #4 plus: Prohibit Application by Irrigation	Additionally, risks from irrigation are eliminated, but growers switching to injection would be exposed to the same risks as in #4.		None	None	Impacts on growers uncertain. If all 450 growers who irrigate switched to injection, their application costs would total $75,000-$327,000 per 3 yrs. on 9,336 acres, or $166-$726 per grower per 3 yr. cycle. Although soil injection can cause some root damage, most growers would probably use it, since DBCP is necessary for economic production. However, if all growers who irrigate stopped using DBCP, the impact would be the equivalent of cancellation for them (~$13.8M).		
6. Cancel Registrations	All DBCP risks are eliminated.		No substitutes available.		$13,800,000 per 3 yr. cycle.	Up to 20% price increases	38% of California acres would go out of production in 3-5 yrs,

TABLE 27, IMPACTS OF REGULATORY OPTIONS FOR DBCP ON ALMONDS IN CALIFORNIA.

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (1,108 applicators)	For cancer risk, see Tables 3 and 4 for specific risk estimates. There is also a risk of decreased sperm count; this risk cannot be quantified.	None	None	Nematode control continues	Current prices continue	Unreasonable risks continue for applicators.
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During Application.	For mixing and loading, dermal risks are reduced nearly 100%, and inhalation risks reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment.	"	Grower compliance is likely.
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.	Additionally, risks during irrigation application and from reentry after irrigation are reduced by factors of at least 50 and 6, respectively.		None	None	"	"	"
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during all other application methods and from reentry after these methods are reduced by factors of at least 50 and 13, respectively.		None	None	"	"	"
5. #4 plus: Prohibit Application by Irrigation	Additionally, risks from irrigation are eliminated, but growers switching to injection would be exposed to the same risks as in #4.		None	None	Impacts on growers uncertain. If all 1,108 growers who irrigate switched to injection, their application costs would total $565,000-$2,888,000 per 3 yrs. on 70,000 acres, or $510-$2,606 per grower per 3 yr. cycle. Although soil injection can cause some root damage, most growers would probably use it, since DBCP is necessary for economic production. However, if all growers who irrigate stopped using DBCP, the impact would be the equivalent of cancellation for them (=$26.5M).		
6. Cancel Registrations	All DBCP risks are eliminated.		No substitutes available.		$26,502,000 per 3 yr. cycle.	Up to 20% price increases	18% of California acres would go out of production in 3-5 yrs.

TABLE 28. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON HOME GARDENS IN THE SOUTH*

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (250,000 home gardeners) & ingestions by 2,000,000.	For cancer risk, see tables 2,3 & 4 for specific risk estimates. There is also a risk of decreased sperm count; this risk cannot be quantified.	None	None	Nematode control continues	Current prices continue	Unreasonable risks continue for home gardeners and others who eat crops from treated gardens.
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During Application.	For mixing and loading, dermal risk are reduced nearly 100% and inhalation risks are reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment.	-	Grower compliance is unlikely.
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.			NOT APPLICABLE				
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during application and from reentry after application are reduced by factors of at least 50 and 13, respectively.		None	None	-	-	-
5. #4 plus: Prohibit Application by Irrigation			NOT APPLICABLE				
6. Cancel Registrations	All DBCP risks are eliminated.		No substitutes available.		Neglig.	Neglig.	Some production decreases may occur for affected home gardeners.

*/ 19 of 23 of these crops have been unconditionally suspended by the Administrator's Suspension Order of October 27, 1977. The four crops in which no DBCP residues are expected are lima beans, okra, snap beans and southern peas.

Table 29. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON HOME LAWNS IN FLORIDA

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS	DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	HOMEOWNERS	
1. Continued Registration	Inhalation and dermal (125,000 homeowners).	For cancer risk, see Tables 3 and 4 for specific risk estimates. There is also a risk of decreased sperm count; this risk cannot be quantified.	None	None	Nematode control continues.	Unreasonable risks continue for applicators.
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During application.	For mixing and loading, dermal risk is reduced nearly 100% and inhalation risks reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment.	Homeowner compliance is unlikely.
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.			NOT APPLICABLE			
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during application and from reentry after application are reduced by factors of at least 50 and 13, respectively.		None	None	"	"
5. #4 plus: Prohibit Application by Irrigation			NOT APPLICABLE			
6. Cancel Registrations	All DBCP risks are eliminated.		No substitutes available.		An infested lawn will die after ten years if not treated. It will cost $200 to replace a lawn with turf plugs. Since 5% of the lawns are affected annually, the total impact is $2,750,000 per year.	Potential property value declines may occur for affected homeowners.

TABLE 30. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON ORNAMENTALS IN FLORIDA, GEORGIA AND SOUTH CAROLINA.

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (5,000 nurserymen).	For cancer risk, see Tables 3 and 4 for specific risk estimates. There is also a risk of decreased sperm count; this risk cannot be quantified.	None	None	Nematode control continues	Current prices continue	Unreasonable risks continue for applicators.
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During application.	For mixing and loading, dermal risk is reduced nearly 100% and inhalation risks reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment.	"	Grower compliance is likely.
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.			NOT APPLICABLE				
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during application and from reentry after application are reduced by factors of at least 50 and 13, respectively.		None	None	"	"	"
5. #4 plus: Prohibit Application by Irrigation			NOT APPLICABLE				
6. Cancel Registrations	All DBCP risks are eliminated.		Some wildlife losses may occur from use of mocap and dasanit (see Table 5). The pounds applied cannot be estimated,		Substitutes are less effective, must be applied more often and cost more. On boxwoods, Mocap costs $805/A/8yrs. while DBCP costs only $101/A/8 yrs.	No substitutes registered for home use.	Risks of DBCP would be replaced by some wildlife hazard and homeowners would have to hire commercial applicators to apply substitutes.

TABLE 31. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON APRICOTS, CHERRIES, FIGS AND WALNUTS IN CALIFORNIA

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (negligible number of applicators).	Cancer risk exist if DBCP is applied. There is also a risk of decreased sperm count; this risk cannot be quantified.	None	None	Negligible use of DBCP on these crops.	None	Unreasonable risks could occur if DBCP were to be applied.
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During Application.	For mixing and loading, dermal risks are reduced nearly 100%, and inhalation risks reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment.	"	Grower compliance is likely.
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.	Additionally, risks during irrigation application and from reentry after irrigation are reduced by factors of at least 50 and 6, respectively.		None	None	"	"	"
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during all other application methods and from reentry after these methods are reduced by factors of at least 50 and 13, respectively.		None	None	"	"	"
5. #4 plus: Prohibit Application by Irrigation	Additionally, DBCP risks from irrigation would be eliminated		None	None	"	"	"
6. Cancel Registrations	All potential DBCP risks would be eliminated.		No substitutes available,		The impacts of cancellation are negligible at present, but major losses in production could be incurred if nematodes infested any of these crops.		Although use of DBCP now is very limited, nematode problems could occur in the future, and the impact of not having DBCP could be severe.

TABLE 32. IMPACTS OF REGULATORY OPTIONS FOR DBCP ON BANANAS IN THE UNITED STATES.

REGULATORY ALTERNATIVES	DBCP RISKS TO HUMANS		RISKS FROM SUBSTITUTES		ECONOMIC IMPACTS		DISCUSSION OF ISSUES AND TRADE-OFFS
	ROUTES OF EXPOSURE	RISKS	ENVIRONMENTAL	HUMAN	GROWERS	CONSUMERS	
1. Continued Registration	Inhalation and dermal (Negligible number of applicators).	Cancer risks exist if DBCP is applied. There is also a risk of decreased sperm count; this risk cannot be quantified.	None	None	Negligible domestic use of DBCP on this crop.	None	Unreasonable risks could occur if DBCP were to be aplied/
2. Restricted Use; Clothing and Respirator during Mix and Load; Boots and Gloves During application.	For mixing and loading, dermal risk is reduced nearly 100% and inhalation risks reduced by factor of 50 (i.e., 98%). Risks during application continue.		None	None	$175 per person for protective equipment.		Grower compliance is likely.
3. #2 plus: Respirator and Reentry Interval for Irrigation Application.			NOT APPLICABLE				
4. #2 plus: Respirator and Reentry Interval for All Application Methods.	Additionally, risks during application and from reentry after application are reduced by factors of at least 50 and 13, respectively.		None	None			
5. #4 plus: Prohibit Application by Irrigation			NOT APPLICABLE				
6. Cancel Registrations	All potential DBCP risks would be eliminated.		No substitutes available.		Neglig.		Other countries might follow our example and prohibit DBCP use on bananas, which could result in price increases (from 23.5 to 27.0 cents/lb) and reduced supplies of imported bananas. This impact could total $150,000,000.

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TABLE 33. SUMMARY OF SELECTED COURSES OF ACTION AND THEIR IMPACTS

Use Category	Selected Course of Action	Suspension Requirements in Effect	Human Risks				Economic Benefits 1/		Critical Factors in Selecting Regulatory Options
			Exposed People	Route	Risk Before	Risk After	Grower Impacts	Consumer Prices	
19 Commercial Vegetables 22 Home Garden Vegetables Peanuts	Option 6 (Cancel)	DBCP use not permitted	U.S. populace	Food	2,013 Cancer cases; sperm count decrease	DBCP risk eliminated. Some unknown risks from substitutes may occur.	$11.6 M/yr, $6.8 M/yr.	<0.01% price incr. for affected vegetables. Negligible	1. Without restrictions, risk is unreasonable. 2. No risks reduction methods available. 3. Substitutes available. 4. Home gardeners may not follow restrictions.
			Applicators	Inhalation	<1 case of cancer; Possible sperm count decreases.	"			
				Dermal	" "	"			
				Reentry	" "	"			
Citrus Grapes Peaches/Nectarines Plums Almonds Strawberry Nursery Stock Pineapple	Option 4 (Restricted use)	Restricted Use	Applicators	Inhalation	<1 case of cancer; Sperm count decrease.	Reduced: 98%	Prevent: $27 M/3 yrs. $65 M/3 yrs. $81 M/3/yrs. $14 M/3 yrs. $24 M/3 yrs. $Unknown $ 6 M/3 yrs.	5% price incr. Major price incr, 25% price incr, 20% price incr. 20% price incr. 18% price incr. 9% price incr,	1. Without restrictions, risk is unreasonable. 2. Risk can be reduced at minimal cost to growers. 3. Prohibiting irrigation (option 5) would cost much for growers, with little reduction in risk. 4. There are no alternative
				Dermal	"	99%			
				Reentry	"	94%			
Apricots Cherries Figs Walnuts Other Berries Bananas	Option 4 (Restricted Use)	Restricted Use	(Same risks as described for Citrus, Grapes, etc.)				Unknown impacts for apricots, cherries, figs and walnuts if DBCP cancelled. Prevent: $1 M loss for berries. $150 M.price incr.in consumer prices of bananas if other countries cancel DBCP.		1. If used without restrictions, DBCP could cause unreasonable adverse effects. 2. Risk can be reduced at a reasonable cost. 3. There are no registered substitutes; DBCP might be needed in the future if a nematode problem occurs.

Soybeans Cotton	Option 4 (Restricted Use)	Restricted Use	(Same risks as described for Citrus, Grapes, etc.)	**Prevent:** $23.5 M/ yr. $ 2.6 M/ yr.	<0.25% price increase Negligible effect on prices.	1. If used without restrictions, DBCP could cause unreasonable adverse effects. 2. Risks can be reduced at a reasonable cost. 3. Registered substitutes are available, but they either cost too much or may cause adverse human effects.
Commercial Lima Beans, Okra, Snap Beans and Southern Peas	Option 4 (Restricted Use)	Restricted Use	(Same as above for Citrus, Grapes, etc.)	**Prevent:** $ 2.4 M/ yr.	Unknown effect on prices.	1. If used without restrictions, DBCP could cause unreasonable adverse effects. 2. Risks can be reduced at a reasonable cost. 3. Registered substitutes are available, but they may cause adverse human effects.
Turf and Ornamentals	Option 4 (Restricted Use by Certified Commercial Applicators Only)	Restricted Use by Certified Commercial Applicators Only.	(Same as above for Citrus, Grapes, etc.)	**Prevent:** $ 2.4 M/ yr. for home lawns. $ 2.2-$5.6M/yr (golf courses) $ Unknown loss for ornamentals		1. If used without restrictions, DBCP could cause unreasonable adverse effects. 2. Risks can be reduced at a reasonable cost. 3. Registered substitutes are either not available or not as efficacious as DBCP. 4. Home owners not likely to buy and use protective equipment.
TOTAL IMPACTS:			Cancer risk << 1 case cancer/yr Reproductive risk reduced by 98%. Some risks to humans may result from use of substitute fumigants on peanuts and vegetables.	$11.6 M/ yr. and <0.1% increase in prices. (Vegetables) $ 6.8 M/ yr and no increase in prices (Peanuts) $ 3.4 M for one-time investment in protective equipment by 31,000 growers.		

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